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DEPARTMENT OF HOUSING AND URBAN
DEVELOPMENT—INDEPENDENT AGENCIES
APPROPRIATIONS FOR 1987

HEARINGS
BEFORE A
SUBCOMMITTEE OF THE
COMMITTEE ON APPROPRIATIONS
HOUSE OF REPRESENTATIVES
NINETY-NINTH CONGRESS
SECOND SESSION

SUBCOMMITTEE ON HUD—INDEPENDENT AGENCIES

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PART 3

Office of Science and Technology Policy.....	Page 1
National Science Foundation.....	75

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(II)

**DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
INDEPENDENT AGENCIES APPROPRIATIONS FOR 1987**

THURSDAY, MARCH 13, 1986.

EXECUTIVE OFFICE OF THE PRESIDENT

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WITNESSES

JOHN P. McTAGUE, ACTING SCIENCE ADVISOR TO THE PRESIDENT
JERRY D. JENNINGS, EXECUTIVE DIRECTOR AND ACTING DIRECTOR, OSTP

Mr. BOLAND. The Committee will come to order.

You know Bill Green. We are delighted to have with us today the OSTP, and we are pleased to have with us John Paul McTague, Acting Science Advisor to the President and Acting Director of OSTP, and Jerry Jennings, Executive Director.

You have been here before.

Mr. JENNINGS. Yes, sir.

Mr. BOLAND. How many times have you been here?

Mr. JENNINGS. Four.

Mr. BOLAND. Nice to have you.

Looking at the box score, John, let's see. Your 1986 estimate is \$2,217,227, which includes sequestration of \$100,000 pursuant to the Gramm-Rudman-Hollings, 15 permanent positions in 1986, and 23 workyears.

Your 1987 request is \$1,671,000, 15 positions in 1987 with, again, 23 workyears.

Why don't you go ahead with your statement?

OPENING STATEMENT

Mr. McTAGUE. We are all aware that this is a watershed year for fundamental changes which will affect all segments of our nation for many years to come. Last year the Congress and the President set the stage with the enactment of the Gramm-Rudman-Hollings Act. This enforces a discipline for building one leg of the stool for the long-term strength and prosperity of our country.

Absence of crippling debt is necessary for strength and prosperity, but it is not sufficient. We must also have the military capability to deter any potential aggressor, and the technological and human resources to compete effectively in an increasingly international marketplace.

These are the two remaining legs that the President and the Congress are now crafting. The proposed budget for fiscal year 1987 which the President submitted to the Congress sets the priorities for all three legs. It meets the Gramm-Rudman-Hollings target for deficit reduction to 144 billion dollars. This places a severe constraint on the discretionary component of the budget, which itself is only about one-fifth of the total federal budget. That means that, in fiscal year 1987 and beyond, the Federal Government can fund only those activities that are necessary for it to fund, not those which are merely good and worthy.

The proposed fiscal year 1987 R&D budget gets us back on an even keel from the formula cuts of fiscal 1986, partially and selectively restoring the trend of real growth experienced in the first half of the 1980s. Because of the long-term nature of research and science and engineering training, and the fragility of research teams, steady, predictable funding is especially important for optimizing future returns on our R&D investment.

From 1985 to 1987, basic research obligations are proposed to rise at an annual rate of 1.7 percent in real terms, or approximately one-third of the growth rate experienced in the first half of this decade.

ACADEMIC BASIC RESEARCH

As in the past, support of basic research, particularly in universities, constitutes a major thrust of the President's responsible, austere R&D budget for fiscal year 1987, with funding at a proposed level of \$8.6 billion. Sustained support of academic basic research is a government priority of the highest order; despite the necessity of budgetary constraints, it is an area which we cannot afford to sacrifice.

Conventional wisdom says that the tangible dividends paid by our investment in basic research can be many years distant. In terms of the technological applications that ultimately improve the quality of our lives, ensure our national security, and enhance our industrial capabilities, the transition period is, indeed, unpredictable and often long. To argue that university basic research does not reap an important, indeed essential, product in the short term, however, is to lose sight of the mission of our universities—to educate. There are thousands of "products" generated every year on our nation's campuses. The assembly line is a procession of young people in caps and gowns marching to receive degrees and going out into the nation's work force armed with the knowledge and experience gained in the classrooms and laboratories of our colleges and universities. The consumer is industry, which relies today more than at any time in the past on the individual skills of well-educated graduates. Without question, federally-supported university research does have a short-term impact on America's industrial competitiveness, and that impact is people. Indeed, in excess of sixty thousand scientists and engineers receive financial support for their education each year from federal research dollars.

R&D BUDGET

An essential aspect of the proposed fiscal year 1987 R&D budget is the fact that, through careful examination of our priorities, we will be able to support important new starts across the R&D-supporting agencies. It will enable the construction and operation of accelerator facilities, regaining U.S. leadership in high-energy physics and materials research at a time when discovery is occurring at a breakneck pace. The joint NASA-DOD project to develop and demonstrate the technologies for a revolutionary class of aerospace plane can also become a reality. Importantly, the budget request also allows for expansion in the use of existing facilities and growth in R&D activities already underway.

OSTP BUDGET

I would like to conclude by saying a few words about the Office of Science and Technology Policy. It is all well and good to invoke the organic legislation and talk about the office's broad-ranging analytical and advisory responsibilities to the President, our routine collaborative efforts with the Office of Management and Budget to plan and coordinate the Federal government's R&D activities, to offer advice and counsel on matters of science and technology to the National Security Council and other agencies of the Executive Office of the President and the Executive Branch, and to act as the Administration's spokesman to Congress on scientific and technological issues, but that doesn't tell the whole story.

A consequence of the diversity of our functions, in my view, is that the full scope of our work is rarely perceived. OSTP is a little like an Impressionist painting; if you don't stand back, you miss the picture. All you see are the tiny dots of color. It's an ironic dilemma, in light of the fact that it is precisely our mission to see the thing whole.

Almost all advanced nations around the globe have responded to the importance of science and technology in government policies and activities by establishing a Ministry of Science and Technology, or its equivalent. Our more decentralized system of government has, characteristically, responded more diffusely. Line authority for S&T efforts is distributed among a large number of departments and agencies. Many of these efforts overlap, so some high-level focus for coordination is needed.

FCCSET COMMITTEE

Let me illustrate by an example, materials research. Major materials programs exist in DOD, DOE, NASA, NSF, DOI, and NBS, and several other agencies have smaller efforts. The Interagency Committee on Materials (COMAT), which I chair, coordinates these efforts to ensure that they complement each other and that they, in sum, address all the Federal government's needs in the field. COMAT also coordinates closely with academe and industry. COMAT is only one of a dozen committees reporting to the Federal Coordinating Council on Science, Engineering and Technology (FCCSET), the others being Atmosphere and Oceans; Federal Laboratories; Food, Agriculture, and Forestry Research; Human Sub-

jects; Intellectual Property; Ocean Pollution; Radiation Policy; Solar-Terrestrial Research; Supercomputers; and the newly-established Committee on International Science, Engineering and Technology, and the Biotechnology Science Coordinating Committee.

Notably, the FCCSET was mandated by Congress, with the OSTP Director as Chairman, specifically to provide a forum for coordination and communication among the heads of R&D-supporting agencies and focusing on significant national and international scientific and technological issues cutting across areas of shared responsibility. In other words, it is one means of avoiding the kind of costly, unproductive duplication of effort which the Federal government can least afford in the current climate of deficit reduction. In the technology-intensive contemporary world, with federal R&D budgets and activities growing in strength and numbers, the need for such coordination is increasing, not decreasing.

During the past year OSTP's responsibilities have grown to encompass areas of emerging importance and concern worthy of mention here.

INTERNATIONAL SCIENCE AND TECHNOLOGY

In the realm of international science and technology, OSTP has taken the initiative to utilize our nation's scientific and technological capabilities and resources as a powerful foreign policy tool to strengthen our close partnership with our advanced allies, influence our expanding relationships with developing countries, and underscore the changing political climate and competition with the Soviet Union.

Science and technology highlighted the agenda of Indian Prime Minister Rajiv Gandhi's June visit to the U.S., during which he and the President renewed for an additional three years the Presidential Science and Technology Initiative (STI). OSTP formulated the STI concept in 1982, drawing on the expertise of a blue ribbon panel of eminent scientists, and continues to guide and oversee its ongoing operation through the National Science Foundation, which serves the STI as Executive Agent and reports directly to OSTP.

The rapid expansion of our international activities lead to the formation, last December, of the FCCSET Committee on International Science, Engineering and Technology. This committee convenes senior-level interagency experts to better integrate U.S. international S&T activities into the framework of domestic R&D policies, and to ensure consistent priorities and budgets—clearly more than any one agency could undertake alone.

NATIONAL SPACE STRATEGY

OSTP also played a key role in the formulation of the National Space Strategy, and was a major participant in the establishment of a National Commission on Space to identify goals, opportunities, and policy options for U.S. civilian space activities for the next twenty years. From the outset, we have been actively involved in the interagency effort to determine the consequences of the tragic loss of the Space Shuttle Challenger.

Together we are proceeding systematically to evaluate the alternatives. At the proper time, we will move ahead with a safe, effective plan of action.

BIOTECHNOLOGY

Perhaps our most challenging coordination effort has been in the complex and expanding field of biotechnology. A FCCSET Biotechnology Science Coordinating Committee was established last fall to ensure that all regulatory agencies use sound scientific bases for their biotechnology policies. Concurrently, the Domestic Policy Council Working Group on Biotechnology, chaired by OSTP, is devising a regulatory scheme that would provide industry and the research community with an efficient and sensible means for approval of their products and research proposals. Shortly it will publish policy statements describing how OSHA, EPA, USDA, FDA, NIH, and NSF review and approve processes, product, and research projects.

TELECOMMUNICATION RESPONSIBILITY

These examples illustrate not only the breadth of OSTP's coordination responsibilities, but also our responsiveness to emerging technologies, opportunities, and problems. Equally important, and equally unpublicized, are our day-to-day obligations to the nation. Few are aware that OSTP is a principal agency involved in the development and implementation of telecommunications policy for crises or emergencies. The Director of OSTP is responsible for the provision of information, advice, guidance, and assistance to the President for the management and allocation of telecommunications resources in the event of a national emergency. We are also deeply involved in a variety of critical activities associated with emergency preparedness planning and continuation of government functions. While each of us devoutly hopes never to have to mobilize them, these activities are demanding, pervasive and absolutely essential to national security.

The present era of austerity in the Federal government requires that we all tighten our belts. Can OSTP function effectively with less funding and staff than it has had over the past decade? Yes, it can; and I believe it can do even better with less. However, the character of the Office will change significantly, and difficult choices of activities to terminate will have to be made if the budget decrease is drastic.

Thank you.

[The statement of John P. McTague follows:]

Testimony of Dr. John P. McTague
Acting Science Advisor to the President and
Acting Director, Office of Science and Technology Policy
Executive Office of the President

Before the Committee on Appropriations
Subcommittee on HUD-Independent Agencies
United States House of Representatives

Hearings on the President's Fiscal Year 1987 Budget for
the Office of Science and Technology Policy

March 13, 1986

Mr. Boland and members of the Subcommittee:

I am pleased to have this opportunity to share my perspectives with the subcommittee as you deliberate the federal agency budgets within your purview, including that of the Office of Science and Technology Policy in the Executive Office of the President. In the coming fiscal year--as in the recent past--science and technology will occupy positions of increasing prominence within the Administration's budget request. For that reason, coupled with the fact that this subcommittee is responsible for a number of the research and development supporting agencies, I would like first to comment on our science and technology policy, to which my agency is inextricably tied--in more than name only.

We are all aware that this is a watershed year for fundamental changes which will affect all segments of our nation for many years to come. Last year the Congress and the President set the stage with the enactment of the Gramm-Rudman-Hollings Act. This enforces a discipline for building one leg of the stool for the long-term strength and prosperity of our country.

Absence of crippling debt is necessary for strength and prosperity, but it is not sufficient. We must also have the military capability to deter any potential aggressor, and the technological and human resources to compete effectively in an increasingly international marketplace.

These are the two remaining legs that the President and the Congress are crafting. The proposed budget for fiscal year 1987 which the President submitted to the Congress sets the priorities for all three legs. It meets the Gramm-Rudman-Hollings target for deficit reduction to 144 billion dollars. This places a severe constraint on the discretionary component of the budget, which itself is a

minor share of the total federal budget. That means that, in fiscal year 1987 and beyond, the federal government can fund only those activities that are necessary for it to fund, not those which are merely good and worthy.

The President also has renewed his commitment to research as the third leg, assuring investment in the future. Just last month he stated, and I quote, "Continuing strong support for our nation's science and technology has been and will continue to be a policy of this Administration. The goals of this support are enhanced national security, improved quality of life, and increased international competitiveness. Today, more than ever before, we must use our technological resources aggressively in order to retain international leadership." Unquote.

The proposed fiscal year 1987 R&D budget gets us back on an even keel from the formula cuts of fiscal 1986, partially and selectively restoring the trend of real growth experienced in the first half of the 1980s. Because of the long-term nature of research and science and engineering training, and the fragility of research teams, steady, predictable funding is especially important for optimizing future returns on our R&D investment. From 1985 to 1987, basic research obligations are proposed to rise at an annual rate of 1.7 percent in real terms, or approximately one-third of the growth rate experienced in the first half of this decade.

If there is a single characteristic which epitomizes America, it is how we embrace change and pioneering as a way of life. Our parents and grandparents came here to change their lives, and thousands upon thousands still do so today. The Edisons, Wrights, and Fords of an earlier generation used their individual inventiveness to make a reality out of the seemingly impossible, and created whole new classes of industries which underlie the nation's strength, prosperity, and quality of life.

In the second half of the twentieth century, we more consciously invested in new technology as the output from a continuum of new scientific knowledge and new engineering approaches. The results included military and commercial jet aircraft, lasers, computers, and the enormous field of microelectronics. We strongly benefited from basic research, especially that carried out at our universities, and from the scientists and engineers trained there in a forward-looking research environment.

These lessons have not been lost on the other nations of the industrialized and industrializing world. They too have learned how to systematize technological innovation, and have narrowed dramatically the technological leadership gap. Universally, an increasing fraction of GNP is being

invested on research and development, with Japan showing the most dramatic acceleration, as well as showing an increasing concern for basic research, the area which the U.S. clearly has predominated for many decades.

Unless we respond effectively to this challenge, we face a certain loss of technological and economic leadership in the world, with consequences which are not measured in dollars alone. In short, we need a new national science and technology strategy as we begin to approach the twenty-first century. Fortunately, we already have the seeds of that strategy planted across our country. And it does not require a massive infusion of increased federal funding, but rather more effective use of what we have, together with the reasoned, steady increases the President has proposed.

The rapid emergence of modern biotechnology industries in the U.S. provides a lesson worth studying. Here, enlightened federal support of multidisciplinary basic research in molecular biology, both in universities and federal laboratories, led to the revolutionary technology of gene splicing. Close two-way coupling between university researchers and commercial entities fostered rapid transfer of the genetic technology to engineering of specific products and created a whole new, albeit infant, industry in which we have a world lead.

This example teaches several lessons. One is that the most effective federal role is not to attempt to drive specific commercial technologies, but to support forefront basic research, which will have payoffs not foreseeable at the time of funding. The second is that multidisciplinary efforts can be exceptionally effective in advancing our knowledge. The third is that person-to-person, university-industry research relationships can benefit both partners without compromising the academic environment we so cherish.

Modest redirections of our federal R&D investment to encourage these trends, without perturbing the predominately disciplinary structure of our universities, could have high payoff for our nation, so that it will continue to lead the world in creating the next generation of new industries, whatever they may be.

A principal observation of the President's Commission on Industrial Competitiveness, still instructive a year after the publication of its report, was the value of encouraging stronger ties between government, universities, and industry, suggesting that their traditional aloofness was not in the best interest of the nation. The transition from basic science to technology to product is occurring more and more rapidly, and will continue to accelerate in the future. Moreover, it is not a one-way street. Science

benefits from technology and its products in comparable measure. Thus, closer relationships more in the spirit of a partnership could be mutually--and nationally--beneficial.

For this reason we are aggressively pursuing an initiative to establish university-based, multidisciplinary, problem-focused, science and technology centers aimed at areas of broad national needs and relevant to industrial technology.

The working model for this sort of arrangement is the National Science Foundation's eminently successful Engineering Research Centers program, begun in 1985 following an overwhelming response from the academic community. There are now six such centers addressing a wide variety of research areas including robotics, biotechnology, composite materials manufacturing, and intelligent manufacturing systems. Importantly, the funding agreement stipulated that participating universities and industries collaborate in defining the areas of research to pursue, based on mutual needs. In addition to amassing the forces of industrial and academic scientists to solve technological questions with economic implications, these centers provide a highly stimulating research and learning environment--a training ground of unparalleled opportunity for graduate and undergraduate students alike. NSF plans to add more Engineering Research Centers during the current fiscal year, and the FY '87 budget request contains plans for the operation of a total of about 15. This is a good beginning, but only a beginning. This concept deserves emulation across the broad spectrum of interdisciplinary science, mathematics, and engineering. Indeed, DOD has already begun efforts in this direction through its University Research Initiative.

Notably, establishing multidisciplinary, problem-oriented science and technology centers on campuses is among the foremost recommendations of the White House Science Council's Panel on the Health of U.S. Colleges and Universities, whose report is due out shortly. Chaired jointly by a leader in high-technology industry, David Packard, and a preeminent university physicist, D. Allan Bromley, this panel urgently stressed the need to enable our colleges and universities to grow commensurate with society's growing demand for the new knowledge and new talent which is their product. This calls for an increased federal investment in higher education and for special attention to the maintenance of modern research facilities and instrumentation on our nation's campuses--a call we intend to heed.

As in the past, support of basic research, particularly in universities, constitutes a major portion of the President's responsible, austere R&D budget for fiscal year 1987, with funding at a proposed level of \$8.6 billion.

The case for sustained support of academic basic research cannot be overstated. It is a government priority of the highest order; despite the necessity of budgetary constraints, it is an area which we cannot afford to sacrifice.

Conventional wisdom says that the tangible dividends paid by our investment in basic research can be many years distant. In terms of the technological applications that ultimately improve the quality of our lives, ensure our national security, and enhance our industrial capabilities, the transition period is indeed unpredictable and often long. To argue that university basic research does not reap an important, indeed essential product in the short term, however, is to lose sight of the mission of our universities--to educate. There are thousands of "products" generated every year on our nation's campuses. The assembly line is a procession of young people in cap and gown marching to receive degrees and going out into the nation's work force armed with the knowledge and experience gained in the classrooms and laboratories of our colleges and universities. The consumer is industry, which relies today more than at any time in the past on the individual skills of well-educated graduates. Without question, federally-supported university research does have a short-term impact on America's industrial competitiveness, and that impact is people. Indeed, in excess of sixty thousand scientists and engineers receive financial support for their education each year from federal research dollars.

The same report of the President's Commission on Industrial Competitiveness emphasized that in the international industrial arena, the United States enjoys only two advantages over our competitors: our technology and our talent. Talent is the immediate, short-term return on the federal government's investment in basic research. If we accept the premise that America's leadership depends upon her scientific and technological preeminence, then we must commit ourselves to maintain the talent base which fuels our science and technology enterprise, and that requires a continued, unswerving commitment to academic excellence, manifest in the support of quality basic research in our universities.

The National Science Foundation, the flagship civilian supporter of academic basic research, plans three special thrusts for FY '87. In the realm of biotechnology--burgeoning with possible applications--centers, mini-centers, and individual awards will be funded at a level of over \$100 million. An additional \$27 million will supplement the existing base of \$57 million in computational science and engineering to establish new interdisciplinary teams, enhance existing centers, and support equipment and training. A proposal to

more than double the FY '86 funding level for global geosciences emphasizes interrelated research efforts treating the earth as an integrated system of physical, chemical, and biological processes.

NSF support is particularly important because it complements the basic research programs of other agencies and assists in balancing federal support for promising research across all fields of science and engineering. In addition to its primary role of supporting basic research at colleges and universities through individual project grants, NSF will strive also to provide educational opportunities for future scientists and engineers, with increased emphasis on undergraduate research and education and on research facilities and instrumentation. We simply must attract and retain a larger fraction of our most talented youth in both undergraduate science and engineering programs.

Science is never static, and the United States no longer enjoys the luxury of setting the pace at which developments progress. An essential aspect of the proposed FY '87 R&D budget is the fact that, through careful examination of our priorities, we will be able to launch important new starts across the R&D-supporting agencies. It will enable the Department of Energy to undertake two construction projects, the Continuous Electron Beam Accelerator Facility at Newport News, Virginia, and the 1-2 GeV synchrotron light source at Lawrence Berkeley Laboratory, while also expanding the use of existing accelerator facilities. The Tevatron I proton-antiproton colliding beam facility, recently completed at Fermilab, and the Stanford Linear Collider, are scheduled to begin operation, regaining U.S. leadership in this most fundamental of experimental sciences at a time when discovery is occurring at a breakneck pace.

Approximately \$200 million is requested for a joint NASA-DOD project to develop and demonstrate the technologies for a revolutionary class of aerospace plane with the capability to take off from and land horizontally on a standard runway, cruise in the atmosphere at speeds of up to twenty-five times the speed of sound, or fly into low earth orbit. In addition to anticipated benefits in the areas of defense and space activities, the technologies behind this transatmospheric vehicle could lead to a civilian transport aircraft capable of traveling to any point on the globe within three hours.

NASA plans also to initiate a major new flight project, undertaken jointly with France. The Ocean Topography Experiment (TOPEX), a further development in the study of oceanography from space, will measure the surface landscape of the oceans over a period of three years to further the understanding of the oceans' general circulation patterns.

In addition, NASA will begin instrument development for the International Solar-Terrestrial Physics (ISTP) program. To be planned and executed in conjunction with the European Space Agency and Japan, ISTP is intended to provide a comprehensive effort to measure phenomena associated with the sun-earth interaction chain.

In formulating these plans for the future, we have heeded the advice of several distinguished panels, including the Seitz-Eastman Panel on Large Facilities for Materials Science, which guided the development of the 1-2 GeV synchrotron light source; the Aeronautical Policy Review Committee, whose national aeronautical research and development goals included pursuit of the aerospace plane; the Space Science Board reports, which urged further space-based oceanographic studies; and the Nuclear Sciences Advisory Committee, which influenced the construction of the Continuous Electron Beam Accelerator Facility.

But not all recommendations deal with facilities. The Pimentel Panel on Opportunities in Chemistry reported on several high-leverage areas, such as chemical instrumentation, maintenance and operation, as well as thrusts in the chemistry of life processes and in chemical catalysis. As a result, the FY '87 NSF request for chemistry has a 15 percent increase in chemistry funding over FY '86, not including the Gramm-Rudman-Hollings rescission.

A few years ago, the David Panel reported on the inadequacy of funding for mathematics, as distinguished from computer, research. Over the past two years, we have increased mathematics funding in NSF and DOD by almost 20 percent in real terms.

Again, these responses to valuable advice have been made not because it is good for science, or even because it is good for the nation, but because it is necessary for the nation.

I would like to conclude by saying a few words about the Office of Science and Technology Policy. It is all well and good to invoke the organic legislation and talk about the office's broad-ranging analytical and advisory responsibilities to the President, our routine collaborative efforts with the Office of Management and Budget to plan and coordinate the federal government's R&D activities, to offer advice and counsel on matters of science and technology to the National Security Council and other agencies of the Executive Office of the President and the Executive Branch, and to act as the Administration's spokesman to Congress on scientific and technological issues, but that doesn't tell the whole story.

A consequence of the diversity of our functions, in my view, is that the full scope of our work is rarely perceived. You see the bits and pieces: the White House Science Council issues a report on federal laboratories and you notice we're interested in federal laboratories; the Cabinet Council Working Group on Biotechnology, chaired by OSTP, publishes guidelines for the federal regulation of biotechnology products and you discover we're evolving a coherent regulatory framework for the federal government's role in biotechnology; another report on chemical carcinogens appears in the Federal Register, bringing overnight, national attention to three years of quiet work. OSTP is a little like an Impressionist painting; if you don't stand back, you miss the picture. All you see are the tiny dots of color. It's an ironic dilemma, in light of the fact that it is precisely our mission to see the thing whole.

It is a truism that science and technology are pervasive in our country and, increasingly, in the world. We are all aware that our national security and our economic competitiveness rely heavily on our technological edge. Almost all advanced nations around the globe have responded to the importance of science and technology in government policies and activities by establishing a Ministry of Science and Technology, or its equivalent. Our more decentralized system of government has, characteristically, responded more diffusely. Line authority for S&T efforts is distributed among a large number of departments and agencies. Many of these efforts overlap, so some high-level focus for coordination is needed.

Let me illustrate by an example, materials research. Major materials programs exist in DOD, DOE, NASA, NSF, DOI, and NBS, and several other agencies have smaller efforts. The interagency Committee on Materials (COMAT), which I chair, coordinates these efforts to ensure that they complement each other and that they, in sum, address all the federal government's needs in the field. COMAT also coordinates closely with academe and industry. COMAT is only one of a dozen committees reporting to the Federal Coordinating Council on Science, Engineering and Technology (FCCSET), the others being Atmosphere and Oceans; Federal Laboratories; Food, Agriculture, and Forestry Research; Human Subjects; Intellectual Property; Ocean Pollution; Radiation Policy; Solar-Terrestrial Research; Supercomputers; and the newly-established Committee on International Science, Engineering and Technology and the Biotechnology Science Coordinating Committee.

Notably, the FCCSET was mandated by Congress specifically to provide a forum for coordination and communication among the heads of R&D-supporting agencies and focusing on significant national and international scientific and technological issues cutting across areas of

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In the realm of international science and technology, OSTP has taken the initiative to utilize our nation's scientific and technological capabilities and resources as a powerful foreign policy tool to strengthen our close partnership with our advanced allies, influence our expanding relationships with developing countries, and underscore the changing political climate and competition with the Soviet Union.

Science and technology highlighted the agenda of Indian Prime Minister Rajiv Gandhi's June visit to the U.S., during which he and the President renewed for an additional three years the Presidential Science and Technology Initiative (STI). OSTP formulated the STI concept in 1982, drawing on the expertise of a blue ribbon panel of eminent scientists, and continues to guide and oversee its ongoing operation through the National Science Foundation, which serves the STI as Executive Agent and reports directly to OSTP. Designed to concentrate joint research programs on a few selected areas in which the complementary talents and shared resources of both research teams would produce tangible results of benefit to both countries, the first phase of STI work in the health and agriculture areas has been particularly successful. The STI approach has become a model for U.S. S&T cooperation with developing countries. Importantly, the initiative is a joint venture between partners, not a donor program tailored to a recipient country's basic needs.

The rapid expansion of our international activities lead to the formation, last December, of the FCCSET Committee on International Science, Engineering, and Technology. This committee convenes senior-level interagency experts to better integrate U.S. international S&T activities into the framework of domestic R&D policies, and to ensure consistent priorities and budgets--clearly more than any one agency could undertake alone.

OSTP also played a key role in the formulation of the National Space Strategy, and was a major participant in the establishment of a National Commission on Space to identify goals, opportunities, and policy options for U.S. civilian space activities for the next twenty years. From the

outset, we have been actively involved in the interagency effort to determine the consequences of the tragic loss of the Space Shuttle Challenger. Together we are proceeding systematically to evaluate the alternatives. At the proper time, we will move ahead with a safe, effective plan of action.

Perhaps our most challenging coordination effort has been in the complex and expanding field of biotechnology. A FCCSET Biotechnology Science Coordinating Committee was established last fall to ensure that all regulatory agencies use sound scientific bases for their biotechnology policies. Concurrently, the Domestic Policy Council Working Group on Biotechnology, chaired by OSTP, is devising a regulatory scheme that would provide industry and the research community with an efficient and sensible means for approval of their products and research proposals. Shortly it will publish policy statements describing how OSHA, EPA, USDA, FDA, NIH, and NSF review and approve processes, products, and research projects.

These examples illustrate not only the breadth of OSTP's coordination responsibilities, but also our responsiveness to emerging technologies, opportunities, and problems. Equally important, and equally unpublicized, are our day-to-day obligations to the nation. Few are aware that OSTP is a principal agency involved in the development and implementation of telecommunications policy for crises or emergencies. The Director of OSTP is responsible for the provision of information, advice, guidance, and assistance to the President for the management and allocation of telecommunications resources in the event of a national emergency. We are also deeply involved in a variety of critical activities associated with emergency preparedness planning and continuation of government functions. While each of us devoutly hopes never to have to mobilize them, these activities are demanding, pervasive, and absolutely essential to national security.

The present era of austerity in the federal government requires that we all tighten our belts. Can OSTP function effectively with less funding and staff than it has had over the past decade? Yes, it can; and I believe it can do even better with less. However, the character of the Office will change significantly, and difficult choices of activities to terminate will have to be made if the budget decrease is drastic.

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THE WHITE HOUSE

WASHINGTON

DR. JOHN P. McTAGUE

Acting Science Advisor to the President and
Acting Director, Office of Science and Technology Policy

On January 1, 1986, Dr. John P. McTague became Acting Science Advisor to the President and Acting Director of the Office of Science and Technology Policy in the Executive Office of the President. He was appointed Deputy Director, Office of Science and Technology Policy, on November 8, 1983. Following nomination by President Reagan he was confirmed unanimously by the U.S. Senate.

Dr. McTague was born in Jersey City, New Jersey, on November 28, 1938. Upon completion of high school in the New York area, he entered Georgetown University and received his B.S. degree in chemistry, with honors, in 1960, and earned a Ph.D. in physical chemistry from Brown University in 1965.

From 1964 to 1970, Dr. McTague was a member of the technical staff at the North American Rockwell Science Center. He then served on the faculty of the University of California, Los Angeles as professor of chemistry and member of the Institute of Geophysics and Planetary Physics until 1982, when he was appointed Chairman of the National Synchrotron Light Source Department at Brookhaven National Laboratory. Dr. McTague also was adjunct professor of chemistry at Columbia University.

Dr. McTague is the author of over 80 experimental and theoretical papers in the fields of condensed matter physics and chemistry. He is a member of the American Chemical Society and a fellow of the American Physical Society, and has served as Associate Editor of the Journal of Chemical Physics. Dr. McTague has received senior fellowships from A. P. Sloan, John Simon Guggenheim, and NATO. In 1975 he was honored with the California Section Award of the American Chemical Society.

Dr. McTague is married, has four children, and resides in Potomac, Maryland.

OSTP'S BUDGET REQUEST

Mr. BOLAND. Thank you very much. That last statement is an understatement. The present era in the Federal government of austerity requires us to tighten our belt. You have certainly tightened yours by 40 percent.

Last year, Senator Garn and I met with the former director of OSTP, Jay Keyworth, and discussed some of the serious problems OSTP has had in getting adequate funding from the Administration and from OMB. How much did you request of OMB?

Mr. McTAGUE. About \$2.5 million.

Mr. BOLAND. Whose decision was it to cut it by 40 percent? I presume it was OMB. If you requested OMB for it, that is what you thought you needed.

Mr. McTAGUE. It was not OMB. All of the decisions on budgets in the Executive Office of the President are made in the West Wing.

Mr. BOLAND. You know it is awfully difficult when you are sitting on this side of the table to understand why this particular activity is the White House's activity. It is their shop, actually, is not OSTP?

Mr. McTAGUE. Yes, sir.

Mr. BOLAND. Can you operate with the budget as it is presented to us with the \$1,671,000 request?

Mr. McTAGUE. Yes, sir, I can, but it will involve termination of a very significant fraction of our effort.

ROLE OF OSTP

Mr. BOLAND. What is the role of OSTP? I think we asked Jay Keyworth how he felt, or what his opinion was, vis-a-vis the impact that the science advisors would have upon the President. Are you the devil's advocate on Presidential recommendations, or what?

Mr. McTAGUE. I think there are two ways to look at that question, one of which is to consider what fraction of our activities have to involve the President or the West Wing.

The other is to ask which of the activities are of prime importance. I would say that when we are doing our job properly, in excess of 90 percent of what we do goes no higher.

We are either the court of last resort or the coordinator of highest level. There are activities which involve Presidential decisions, such as the decision to go ahead with the National Aerospace Plan program, where we play a very significant role directly with the White House.

Mr. BOLAND. Really, shouldn't the science advisor to the President be a conduit from the scientific community, and in being that conduit, indicate to the President the feelings within the community vis-a-vis what role the scientific community should play in decisions made by the current Administration?

Are you a conduit from the scientific community?

Mr. McTAGUE. I think I would prefer, from my own perspective, to summarize the role as being one of giving and making available the best, unbiased technical advice possible.

Where that technical advice comes from is often the external scientific community, the White House Science Council, our own staff, and experts in the agencies.

And we try to integrate these and give as good, unbiased advice as we possibly can. It is certainly not our role to be a special pleader, any more than the National Security Council should be a special pleader for the Department of Defense. It should be a conduit of expert opinion.

Once opinion has been jelled by the President, it is clearly my job to articulate that as well as I possibly can and to support his decisions.

Mr. BOLAND. Sometimes, I have a feeling that the science advisor to the President really is a mouthpiece for some of the special programs that he is interested in, like SDI, or even what are we going to do and where we are headed, with reference to the severe problem NASA has.

You consider the advisor to be more than just a mouthpiece for particular programs that whatever administration is in power desires, I presume?

Mr. McTAGUE. Absolutely.

Mr. BOLAND. But mostly you indicate you don't give the President much advice on specific scientific problems or programs, that that comes from within the Federal establishment. It might come from the NSF, might come from the Department of Defense, or might come from other areas that are involved in specific scientific endeavors.

Mr. McTAGUE. To the degree that the Executive Branch of the government is functioning efficiently, a very large fraction of decisions should not have to reach the President.

That is what the rest of us are paid for. It is only issues that call for Presidential leadership that need to go to the President.

Mr. BOLAND. Of course, you interface with all those agencies that deal with the Administration on a scientific level anyway, I presume.

Mr. McTAGUE. Yes, sir.

ACCESS TO THE PRESIDENT

Mr. BOLAND. How often do you see the President?

Mr. McTAGUE. About an average of once every two weeks.

CHALLENGER TRAGEDY

Mr. BOLAND. Let me talk a minute about the impact of the loss which was experienced by NASA in that tragic accident.

That impact, I think, really is unknown both in respect to what is going to be done in the future, vis-a-vis the Shuttle, and the length of time that is going to be required to get NASA back into the space transportation system.

One of the areas that this Committee, and the Science and Technology Committee, have been concerned with is what we should do now that the Shuttle is grounded.

Information from NASA indicates the Shuttle, any shuttle, will not be back in operation until some time a year from now, sometime in February 1987.

Now we are getting into the problem of the Air Force getting what it wants in the expendable launch vehicle area. That was a matter which was a problem, as you know, with NASA and with the Air Force on the use of the ELVs.

My understanding is that the Acting Administrator for NASA issued an order that NASA will no longer accept any additional or new commercial satellite launches.

Do you agree with that policy?

Mr. McTAGUE. The intent of Acting Administrator Graham's directive was to not overcommit NASA in the short-term to obligations that may interfere with its priorities, with its essential priorities, and in particular, not overcommit in areas where there are alternate programs for launch through expendable vehicles.

The Administration, through the Senior Interagency Group on Space, on which I serve, is in the process of formulating a longer-range strategy with respect to the role of NASA relative to commercial launches, in particular, those for which one can foresee alternative possibilities.

FUTURE SHUTTLE LAUNCHES

Mr. BOLAND. Now, as you know, the Air Force does have some priority on future shuttle launches. I am wondering whether or not it ought to still enjoy that priority. The Air Force has been a staunch advocate of ELVs, never really cared too much for the Shuttle, but it had to accept it, because it was there.

Do you think the Air Force ought to lose its priority on the Shuttle?

Mr. McTAGUE. Not in the short term, at least, because there are in the pipeline several assets which are configured to fly on the Shuttle, to be launched by the Shuttle.

ELV'S

Mr. BOLAND. And they cannot be launched in ELVs?

Mr. McTAGUE. They cannot be launched without massive configurations, perhaps it is not practical. I am not certain of that.

Now, if you ask the question, "What can we do five years out?," that is another issue.

Mr. BOLAND. Now, this problem involving the issue of what is the right balance of ELVs and the purchase of a replacement orbiter has been discussed, I understand, at a number of meetings of the senior interagency group on which you serve. What has been the position of OSTP in these matters, and have you had or stated a position during the meetings of SIG?

Mr. McTAGUE. We have consistently, since I have been in OSTP—which is almost two and a half years—supported the position that we should encourage the potential of commercial ELV operation, and have supported positions with respect to Shuttle pricing that would have made that more commercially advantageous.

The whole issue, as I mentioned, is presently being reexamined, and it is premature to state what the Administration position will be. But it will be arrived at, presumably, within the next two to three weeks.

Mr. BOLAND. I suppose whether or not there ought to be a replacement orbiter, which probably runs in the neighborhood of about 2.5 billion dollars, is a policy decision of the Administration. What is the position of the OSTP, or what is the position of the Administration?

Mr. McTAGUE. There is not an Administration position yet. I can tell you about my own deliberations, and that is that there is only one shuttle left that is configured for certain payloads, and having only one is a precarious position to be in. Unless we procure a second orbiter that is properly configured for some of these payloads, we are in a very difficult position with respect to insuring the future.

Mr. BOLAND. You say there is only one shuttle left?

Mr. McTAGUE. That is configured to carry certain types of payloads into orbit, yes.

Mr. BOLAND. Bill, do you have any questions?

Mr. GREEN. Yes. We have now been put in the position where one ought to be able to see whether there is any commercial market for ELVs.

Our prognosis is that it is backed up on the Shuttle. Won't that be a test of our program prognosis?

Mr. McTAGUE. Yes. One of the questions to be asked also is, do we in the intermediate term—let's say within the next five-year range—foresee the possibility, through new technology or improved usage of existing technology, to significantly—but not dramatically—lower the cost of launch by commercial ELV. The White House Science Council is about to take up that issue, to look specifically at the five-year time frame.

Is it conceivable that the cost of commercial launch might drop or could be dropped by a factor of two, for example, which would make a very significant difference.

Mr. GREEN. It certainly would, but again, does it require any action on our part now to test the market? It would seem to me that the pricing of the Shuttle is almost irrelevant at this point.

Mr. McTAGUE. I think in the short term you will see a stimulation of the commercial market, because the Shuttle will not be able to carry all the loads over the next several—maybe three—years, that I foresee.

ARIANE doesn't have the flexibility to pick up the loads, which looks like two or three years out.

Over the next year, I think the situation is sufficiently elastic that, except for some of the Air Force payloads, there isn't a severe problem. And, in the commercial sector over the next 12 months, there is not a severe problem.

PEER REVIEW

Mr. BOLAND. Let me ask, does your office concern itself with peer review on particular projects that might be recommended or inserted into the budget?

Mr. McTAGUE. No.

Mr. BOLAND. It does not concern itself?

Mr. McTAGUE. Not with specific proposals.

Mr. BOLAND. I am sure you don't sit and review them, but do you express any concern over the fact that some of the activities, some of the actions taken by Congress in specific or special projects, are done without the peer review process? Are you familiar with that?

Mr. McTAGUE. Yes, absolutely.

Mr. BOLAND. Do you have any objection to that?

Mr. McTAGUE. I believe the peer review process, or rather I would say the review by experts, has served us exceedingly well.

Abandoning that is fraught with uncertainty, and I don't see the advantage of doing that. In particular, I have been concerned in the past year with the new precedent for grants for research—as opposed to construction—being inserted by Congress without even Congressional Committees conducting hearings on, or examining, the quality of the programs.

Much as I respect Congress, I have seen little sign that there is the capability to evaluate the relative quality of professor X on campus A, as compared to professor Y on campus B, and I believe that abandonment of support of excellence with respect to the human aspect of research would be very dangerous.

Mr. BOLAND. I presume with only 15 employees or 23 workyears, you don't have an opportunity to get a look at other R&D Agency budgets, anyhow. For instance, if the appropriation is reduced the DOD is impacted with a number of projects that have not gone through the peer review process, both for construction and research grants. You don't have an opportunity to get a look at that, do you? That would be an impossible task.

Mr. McTAGUE. The number is still sufficiently small, and the principle at stake is sufficiently high, that I personally spent significant time last fall on that activity.

Mr. BOLAND. You did?

Mr. McTAGUE. Yes, sir.

Mr. BOLAND. Did you make any recommendations?

Mr. McTAGUE. Yes, I did.

Mr. BOLAND. Were they adopted?

Mr. McTAGUE. Most of my recommendations were made to Congressional Committee staff, and some of them were adopted and some of them weren't.

Mr. BOLAND. Are you satisfied with the disproportionate split between research and development dollars that go to the Department of Defense and those which go to other government agencies? I believe DOD now gets about 90 percent of all R&D dollars. That is correct, is it not?

Mr. McTAGUE. No, sir. It is about 70 percent.

Mr. BOLAND. Well, is that a kind of split that you are satisfied with?

Mr. McTAGUE. I think you have to qualify that. If you compare the research and development that is done by agencies other than DOD to that which is done by DOD first, the character is very different.

The largest portion of what is called the "D" in the Defense Department is, in fact, early testing of completed systems. Then was an accounting reform taken in the early 1970's, so, for example, the first three or four launches of an MX missile count in the R&D

budget, and that certainly is not of the character of doing laboratory research.

U.S. INVESTMENT IN R&D

Mr. GREEN. Doesn't that mean that the budget is really overstating U.S. investment in R&D in terms of its capacity to give us products for the future?

Mr. McTAGUE. Yes, sir. But on the other hand, the real question is, are we making enough investment for the long haul, and we are doing more than most in that area, more than anyone.

I don't think we are doing enough. I think, in particular, the Department of Defense should take a longer-range point of view. The contributions to basic research are not commensurate with their previous commitment.

They are slowly building up, and I am optimistic for the future.

CLEANER TECHNOLOGY

Mr. BOLAND. In the joint report which was issued by Drew Lewis and Bill Davis, respectively the U.S. and Canadian special envoys, the recommendation was a \$5 billion research program to demonstrate cleaner technology for power plants to be funded equally by United States industry and Federal Government. Where does that recommendation now stand?

Mr. McTAGUE. That recommendation was for \$5 billion. How to flesh out that recommendation is currently under consideration by a group in the White House, including myself. There will be an announcement shortly.

Mr. BOLAND. What is the Administration's position on the recommendation? This was really an issue of supplying the \$5 billion to it, as you say.

Congress added the money, of course for the "Clean Coal Initiatives." The Administration opposed it. Was that a recommendation made by the OSTP to oppose it?

Mr. McTAGUE. I do not know. I was not the Director at the time. At present the Administration has not officially pronounced its position, and I don't want to preempt the President. As you are aware, there is going to be another Shamrock Summit, shortly.

ACID RAIN

Mr. BOLAND. We have been spending about \$85 million each year on general research and acid rain atmospherics, and cause and effect relationships. There is now a broad scientific consensus in this area. Haven't we reached the time to begin putting some money into research on the solution, that is, affordable technology to reduce emissions? What about this?

Mr. McTAGUE. I think there are two aspects to the answer that, one of which is that there is no doubt that acid deposition is correlated with emissions.

There is still significant research needed to be done on the reverse process, decreasing emissions: what impact does that have, and what time scale is required to decrease the effect.

The information there is incomplete. There is significant research going on in that direction right now.

With respect to technologies for decreasing emissions, there are plenty of technologies that exist. There is a political question of installing them, and of the cost, and of relating the cost to what are present benefits with some wide range of uncertainty.

Mr. GREEN. If the process is a political question and decision to balance the cost of the technology against the savings in terms of reducing the damage that acid deposition does, and if the present research is simply on how long the reduction that emissions takes to take hold, why should that hold up our moving ahead?

What is the difference whether it takes three years or five years? In the sense that the longer it takes to take hold, the harder it is for us, then it would seem there is all the more reason for us to start.

Mr. McTAGUE. I think there is a real question as to, for example, reversals of soil chemistry effects. For example, there was a very interesting report that was just put out by the National Academy of Sciences, or is about to be put out, I think, maybe tomorrow, which studies the historical records through lake beds, etc., the information that is attainable since 1900, roughly.

In some areas of the country there is acidification, and in other areas of the country alkalization, and in some areas where there is acidification there is impact on the lakes, and in some areas there isn't. It is a very thorough, thoughtful study, I think, that is worth examining.

The question of what benefit you get by reducing emissions will probably vary markedly in different areas of the country.

For example, in the Midwest, most of the soils are becoming alkaline, presumably because of agricultural effects, fertilizers, etc.

It is more than a question of SO₂ emissions from coal-burning power plants. It is a very much broader issue than that, and it must be judged in the overall political context, in my opinion.

Mr. GREEN. I don't think any of us would quarrel with that. It is a question of what are the costs and benefits.

I am just not sure any advantage in delaying reaching that decision.

Mr. McTAGUE. There is a real question on the benefits, in my opinion.

ARIANE

Mr. BOLAND. Let me ask one other question about the ELV's before we get into the budget. Can any U.S. commercial ELV compete with the ARIANE?

The OSTP last year indicated that they could.

Now, of course, we are going to have a chance to find out whether or not the commercial ELVs really can compete. And I would hope that we don't subsidize ELVs now. Would you agree with that?

Mr. McTAGUE. Yes, sir.

Mr. BOLAND. Did you have something, Bill?

REPLACEMENT OF LAUNCH CAPABILITY

Mr. GREEN. Before we get to the budget questions, I have a couple of questions.

First, getting back to the question of how we replace the launch capacity of the lost orbiter, I gather there was an interview in the Baltimore Sun today in which the President was quoted as indicating that he wouldn't seek supplemental funding until after the Rogers Commission report gets in.

Is that the basic time table we are looking at from the Administration's point of view?

Mr. McTAGUE. I think that is a very reasonable thing to do. The delay of a few months, during which we will be obtaining a much better information base, would clearly make sense, and there is elasticity, as you know, in the NASA budget this year for funds which could be reprogrammed to do whatever is necessary in the short term.

INDIRECT COSTS

Mr. GREEN. If I could turn to another policy question, were you involved at all in OMB's circular A21 and the proposed ceiling on indirect costs?

Mr. McTAGUE. Yes, sir.

Mr. GREEN. Could you tell me how the initial 26 percent level was set or the subsequent 26 percent level?

Mr. McTAGUE. The Office of Science and Technology Policy, at the request of then-Secretary Heckler, did a study of what should be done with respect to the problem of administrative costs, which are very difficult to audit and have been the source of great controversy and of great fractional increase over the past decade.

We recommended that, since it is very difficult to audit, a simple policy be enacted. The policy which was recommended didn't require audit, namely, giving a uniform amount to all universities, set, perhaps at the five-year average for all, which now is about 26 percent.

That is where the 26 percent number came from. We recommended it in that narrow context. In a broader sense, this issue has been looked at by the White House Science Council Panel on the Health of Universities, chaired by David Packard, and vice-chaired by Professor Al Bromley of Yale.

The panel looked at this issue in the context of the overall relationship between the Federal government and universities, including, for example, making full reimbursement for realistic cost of depreciation of buildings, etc.

In their context, the panel recommended the uniform rate, but only as a part of the full package. The present proposal by OMB addresses only a part of the issue, and I think the issue should be looked at in the full context.

Mr. GREEN. That was the point I was about to make. Isn't it unfair to the colleges and universities to oppose the one part which may create some problems for them without also putting into effect the parts which could be helpful to them?

Mr. McTAGUE. It is clearly my recommendation that we view the issue as a whole: how the Federal government views its relation-

ship with universities, in particular the notion that we support research at universities as an investment in the future, rather than a procurement of specific research results. Most of the auditing procedures are oriented more toward standard procurement policies.

AERONAUTICAL VEHICLES

Mr. GREEN. If I could turn to the so-called Orient Express, it has been my impression looking back over the last couple of decades, that these projects which try to produce aeronautical vehicles that are going to be made up of parts that have not worked out all that well.

You have McNamara's plane with the moveable wings, and that really never panned out the way it was hoped.

Even in terms of the FA-18, while it has produced an excellent fighter plane, I think there are many of us who are very concerned that the very short range of the attack plane—particularly in view of the very aggressive role that the Secretary of the Navy seems to contemplate for attack planes on aircraft carriers—is it realistic for us to embark on a venture which is going to produce, in theory, a breakthrough in commercial aviation, a breakthrough in military aviation, and the successor to the Shuttle?

Is that realistic?

Mr. McTAGUE. I think, perhaps, we have not articulated as clearly as we could have the full nature of this program.

The National Aerospace Plane Program that the President discussed in the State of the Union message is a research and development program related to the technologies toward creating what would undoubtedly be separate classes of vehicles that would do these separate things, such as commercial transport, such as a vehicle for bringing payloads into orbit, such as a defense of a pop-up plane.

The underlying technologies have a common base, and the program that the President proposed in the State of the Union, in fact, was to explore these technologies to get to the stage of creating one or two demonstration vehicles from which one would then further bifurcate or "trifurcate," if there is such a word, to the actual vehicles as they are needed.

Mr. GREEN. Could you spell out what that common base is, as you see it?

Mr. McTAGUE. The common base is the full integration of advanced Ramjet/Scramjet technologies into a fuselage. It is an enormous integration problem, very different from how one presently designs an aircraft, which is an engine attached to a frame. Here, because of the air flow that is necessary, it must be a completely integral vehicle. Very high temperature materials are needed because of the high speeds that are involved in the Scramjet and pure rocket phases.

There are a considerable number of advanced aerodynamic designs in remodeling, all of which have a common technical base. I think what we are seeing is, in fact, the coalescence or the maturity, roughly, simultaneously, of several sets of technologies such that this overall goal is within our grasp.

Mr. GREEN. In a way, it sounds like what we set out to do with the Shuttle.

Mr. McTAGUE. I wasn't around when those decisions were made, but the Shuttle, at least as it has ended up, has been essentially a single-type vehicle. Whereas the fruits of the Aerospace Plane Research Program will undoubtedly be at least three distinct sets of vehicles with a common technology base.

Mr. GREEN. Thank you, Mr. Chairman.

OSTP SPACE REDUCTION

Mr. BOLAND. We will turn to the budget requests.

The proposal reduces your budget for Fiscal Year 1987 by \$546,000. That reduction is primarily in two areas: \$415,000 in personnel compensation and benefits, and \$108,000 in space rental charges. Looking at some of the space charges, are you in the New Executive Office Building or in OEOB?

Mr. McTAGUE. We are in both, NEOB and OEOB.

Mr. BOLAND. In OEOB, you are charged \$27 per foot for space. Is that a lot?

Mr. JENNINGS. It is about average.

Mr. BOLAND. I guess if you compare it with some of the buildings downtown it is not, is it?

Mr. JENNINGS. The old building is less expensive than the new one. It is about \$27 for the old, \$30 for the new.

Mr. BOLAND. Now, can OSTP function effectively with a 40 percent reduction? Let me ask you, what do you propose terminating as a result of that cut? You must have some priorities that you have established if the cut remains?

Mr. McTAGUE. The priorities, I think, that should be maintained are the essential and unique functions that we perform in emergency preparedness and in continuity of Government. I think that will be the prime thing that I would maintain.

Mr. BOLAND. How much are you doing in that area? You sit on that committee that is responsible for it, but isn't FEMA the lead agency?

Mr. McTAGUE. Not in terms of certain aspects. FEMA is at the operational end.

Mr. BOLAND. They are putting it all together, but what does OSTP do with reference to it?

Mr. McTAGUE. Our role has to do, in particular, with the continuing of the Presidency.

DETAILEES

Mr. BOLAND. How many detailees do you plan to support in 1987 with \$198,000 requested?

Mr. JENNINGS. We will have to reduce by about half what we have now.

Mr. BOLAND. How many detailees are you utilizing in 1986?

Mr. JENNINGS. We will reduce detailees from 20 to 10. The mix is critical there, obviously; not as many senior people as junior people.

Mr. McTAGUE. Congressman, could I answer that question a different way?

Mr. BOLAND. Sure.

Mr. McTAGUE. The budget, as you see it, looks rather skewed, I think in that all of the personnel cuts were taken in detailees

That was a conscious decision on my part to preserve the options of the future director of our office to hire and attract senior-level people, such as Presidential appointees.

The office is authorized up to four executive level and three Presidential appointees. I believe that option should be retained for the next permanent director of the office.

So the budget figures that you see are, undoubtedly, not those which accurately represent how a future director—whoever the permanent director is next year—would allocate those resources.

But the intent was to maintain the flexibility, in particular, with respect to policy-level senior appointees.

PERSONNEL COMPENSATION

Mr. BOLAND. On page 8 in the personnel summary schedule, you indicate being able to support 23 workyears in 1987.

That is the same as 1986. But you are requesting fewer dollars for personnel compensation in 1987 than you have estimated for 1986. How can you do it?

Mr. JENNINGS. Again, we are changing the mix. We will be dealing with fewer senior staff and more consultants. Beyond that we are preserving the options for future staffing for the next permanent director.

USE OF CONSULTANTS

Mr. BOLAND. When you say "using consultants," what do you pay consultants?

Mr. JENNINGS. It varies, depending on their salary history. The max is \$263 a day.

Mr. BOLAND. Do you have any idea how many consultants you are going to use, compared to the number of detailees that you will lose?

Mr. JENNINGS. We have 50 consultants on board now, but it varies. The White House Science Council has 11, and we use them extensively. They are without compensation.

There are 19 consultants that we pay and we could increase the usage of some of them. Now, for the \$263 a day consultants, we won't be saving any money over the detailees.

SPACE

Mr. BOLAND. You have indicated you are going to give up some space. What type of space are you giving up? Is it conference rooms, office space, or storage space?

Mr. McTAGUE. There is a significant problem there. The space that we have in the New Executive Office Building, which is where almost all of the staff is, is quite integral space, because it is high-security space.

It was set up as a single, integral, high-security area about two years ago.

Jerry?

Mr. JENNINGS. Three years ago.

Mr. McTAGUE. At a significant cost. Breaking off one portion of that, which is the intent under these reductions, would mean loss of the high-security aspect for over half of our space. I see difficulty there.

Mr. JENNINGS. The security enhancement package was approved by this Committee, and we brought Secret Service in along with CIA for a survey.

We have all sorts of monitors in the area. The space is fully controlled during daylight hours, and at night is wired and alarmed.

Mr. McTAGUE. And security phones are in all of the areas.

Mr. JENNINGS. This area is one wing of one floor of the New Executive Office Building with only one door providing access. Giving up part of that space, obviously, will negate any security advantage we had previously.

GRAMM-RUDMAN-HOLLINGS

Mr. BOLAND. As a result of the Gramm-Rudman-Hollings Act, your 1986 budget was reduced by \$100,000. In what particular activities will the \$100,000 reduction be applied?

Mr. JENNINGS. Sixty-six thousand dollars in object class 11.1, and \$34,000 in object class 11.3.

DETAILEE COSTS

Mr. BOLAND. Now, we are going to go back, again, into detailees. Last year, the Congress provided an additional \$120,000 for OSTP in 1985 for detailees. The Congress also increased the 1986 appropriation by \$164,227 for the same purpose, for reimbursing agencies for detailees to OSTP.

The schedule on page 7 indicates that OSTP plans to obligate \$568,000 for reimbursable details in 1986. What has been the cost of reimbursable detailees to date in 1986? I will give you some questions, Jerry, and you can supply answers for the record.

Mr. JENNINGS. Let me provide that for the record. We are running a little over half for reimbursables.

Mr. BOLAND. How many individuals have been on a reimbursable detail to OSTP so far in fiscal year 1986?

How many non-reimbursable detailees has OSTP utilized to date in fiscal year 1986, and what would have been the cost to date in fiscal year 1986 of those detailees had OSTP paid for their services?

You can supply all that for the record.

Mr. JENNINGS. Just for your information, to January 1 I have it, not to date. It was 16 reimbursable, ten nonreimbursable, for a total of 26; and \$224,666 for reimbursable, \$212,156 for non-reimbursable, for a total of \$436,822.

I will have it updated for the record.

[The information follows:]

DETAILEE COSTS

To date, the OSTP has had 28 different detailees assigned to the Office. The following information is provided regarding reimbursement to date:

Reimbursable detailees (17 individuals)	\$294,470.08
Non-reimbursable detailees (11 individuals)	283,985.66
Total	578,455.74

Mr. BOLAND. This same table on the schedule shows a total of \$584,000 was obligated for reimbursable detailees in 1985.

That amount provided reimbursement for how many detailees in 1985?

Mr. JENNINGS. In 1985 we were dealing with 20 different individuals representing 11 agencies.

Mr. BOLAND. Can you indicate what would have been the cost of those individuals had OSTP paid for their services?

Mr. JENNINGS. \$1,119,525.

Mr. BOLAND. Will you provide a table listing the cost by agency of reimbursable detailees in fiscal year 1985? A similar table can be found on page 45 of last year's hearings.

Mr. JENNINGS. Yes, sir.

[The information follows:]

AGENCY BREAKDOWN

Agency	Reimbursable	Nonreimbursable	Total
Central Intelligence Agency	94,799	28,366	123,165
Department of the Air Force	00	99,330	99,330
Department of the Army	00	49,754	49,754
Department of Energy	4,094	224,996	229,090
Department of the Navy	00	68,401	68,401
National Aeronautics and Space Administration	38,293	00	38,293
National Bureau of Standards	37,322	00	37,322
National Institutes of Health	7,648	00	7,648
National Oceanic and Atmospheric Administration	58,096	00	58,096
National Science Foundation	344,173	00	344,173
U.S. Marine Corps	00	64,253	64,253
Total	584,425	535,100	1,119,525

¹ Rounded to \$584,000.

Mr. BOLAND. Mr. Green?

LANDSAT

Mr. GREEN. If we could just turn to the LANDSAT. It appears as if there has been some change in the way the Administration is going in view of the proposals and support funding for the LANDSAT operation after the awarding of that contract to the EOSAT corporation.

Doesn't this sort of change the situation and impair in a larger sense the Administration policy of trying to commercialize these kinds of things that the government believes belongs in the private sector?

Mr. BOLAND. The question is, when you break the umbilical cord?

Mr. GREEN. Isn't this a lot earlier than anyone had really anticipated, and doesn't that create some doubts?

Mr. McTAGUE. It is a change from the original plan.

Mr. GREEN. Isn't that going to hamper future privatization efforts which, to some degree, depend on government business?

Mr. McTAGUE. The important thing is that, whatever happens, there be a predictable policy in the future.

That is the most important thing, so that anyone wishing to do such business will have some way to estimate what the cost of his business will be.

Mr. GREEN. That was scarcely predictable in this case.

Mr. McTAGUE. That is correct. So is Gramm-Rudman scarcely predictable.

Mr. GREEN. Thank you, Mr. Chairman.

Mr. BOLAND. John, thank you very much.

Thank you, Jerry.

[Justifications follow:]

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUMMARY AND HIGHLIGHT MEMORANDUM -- FISCAL YEAR 1987

The Office of Science and Technology Policy (OSTP) was created by the National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282). The Office serves as a source of science and technology expertise for the President and other organizations within the Executive Office of the President; provides for coordination and policy analysis of research and development programs of the Federal government; and conducts reviews and analyses, with the Office of Management and Budget, of research and development programs of the Federal government.

Major objectives of the OSTP include the following:

- Advise the President on scientific and technological considerations involved in areas of national and international concern.
- Assist the Office of Management and Budget with reviews of proposed budgets for Federal R&D programs.
- Advise the National Security Council on the scientific and technological factors related to national security and international issues.
- Advise the Office of Policy Development and other EOP units on matters concerning science and technology.
- Provide general leadership and coordination of the research and development programs of the Federal government; analyze problems and developments in science and technology affecting more than one Federal agency and recommend policies and procedures for dealing with them.
- Encourage a stronger partnership between Federal research, State and local governments, and the scientific community.
- Provide Executive Branch perspectives regarding science and technology policy to the Congress.

The Office is headed by an Acting Director who was appointed in January 1986, one Deputy Director appointed July 1984, an Executive Director, and six Assistant Directors.

The White House Science Council was established to advise the Director on science and technology issues of specific concern to the President as well as other issues of importance to the nation. The Council has concerned itself with a number of issues assigned by the Director and has also kept him informed of changing perspectives in the science and technology communities.

In addition, OSTP augments the capabilities of the staff by obtaining advice and services of consultants, detailees, advisory groups, and interagency panels.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WASHINGTON, D.C. 20508

January 5, 1986

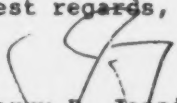
Enclosed you will find the Office of Science and Technology Policy's budget submission for Fiscal Year 1987. There are some changes from the figures printed in the FY 87 Appendix, Budget of the United States Government. The differences in the Appendix resulted from printer error.

The changes, noted on page I-C11, are as follows:

<u>Entry</u>	<u>Correct Information</u>
71.00 Obligations incurred, net (FY 87) 2,198 reflected	1,671
22.0 Transportation of things (FY 87) 2 reflected	3
Total number of full-time permanent positions 15 reflected	11
Full-time equivalent employment 23 reflected	20

If I can be of any further assistance, do not hesitate to contact me at 395-4692.

Best regards,


Jerry D. Jennings
Executive Director

Enclosures

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

General and special funds:

Salaries and Expenses

For necessary expenses of the Office of Science and Technology Policy, in carrying out the purposes of the National Science and Technology Policy, Organization, and Priorities Act of 1976 (42 U.S.C. 6601 and 6671), hire of passenger motor vehicles, services as authorized by 5 U.S.C. 3109, not to exceed \$1,500 for official reception and representation expenses, and rental of conference rooms in the District of Columbia, [\$2,343,000] \$1,671,000: Provided, That the Office of Science and Technology Policy shall reimburse other agencies for not less than one-half of the personnel compensation costs of individuals detailed to it.

[Sec. 416. Notwithstanding any other provision of this Act, amounts otherwise provided by this Act for the following accounts and activities are reduced by the following amounts: "Office of Science and Technology Policy", \$25,773;] (Department of Housing and Urban Development-Independent Agencies Appropriations Act, 1986.)

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Program and Performance

The Office of Science and Technology Policy (OSTP) provides advice to the President concerning policies in science and technology in and on the utilization of science and technology in addressing important national problems. The OSTP operations include support to other Executive Office of the President organizations on issues with science and technology considerations; review and analysis, with the Office of Management and Budget, of research and development budgets for all Federal agencies; coordination of research and development programs of the Federal Government; and other activities necessary to carry out the duties, functions, and activities described in Public Law 94-282, the National Science and Technology Policy, Organization, Priorities Act of 1976.

1. **Project Name:** [Project Name]
 2. **Project Manager:** [Project Manager]
 3. **Project Sponsor:** [Project Sponsor]
 4. **Project Start Date:** [Project Start Date]
 5. **Project End Date:** [Project End Date]

STANDARD FORM 300
July 1963, Bureau of the Census
GSA GEN. REG. NO. 27, 100-10
5010-108

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
SALARIES AND EXPENSES

Program and Financing (in thousands of dollars)

Classification code	85	86	87
11-2600-0-1-802			
Program by activities:			
10.00 Total obligations.....	2,300	2,317	1,671
Financing:			
25.00 Unobligated balance lapsing.....	34	---	---
39.00 Budget authority.....	2,334	2,317	1,671
Budget authority:			
40.00 Appropriation.....	2,334	2,343	1,671
40.00 Reduction pursuant to P.L. 99-160.....	---	- 26	---
43.00 Appropriation (adjusted)...	2,334	2,317	1,671
Relation of obligations to outlays:			
71.00 Obligations incurred, net.....	2,300	2,317	1,671
72.40 Obligated balance, start of year.....	909	1,061	1,061
74.40 Obligated balance, end of year.....	-1,061	-1,061	- 850
77.00 Adjustments in expired accounts..	- 17	---	---
90.00 Outlays.....	2,131	2,317	1,882
-			

SUMMARY OF BUDGET AUTHORITY AND OUTLAYS

(in thousands of dollars)

	<u>1985 actual</u>	<u>1986 estimate</u>	<u>1987 estimate</u>
Enacted/requested			
Budget authority	2,334	2,317	1,671
Outlays	2,131	2,317	1,882
Reduction pursuant to P.L. 99-177			
Budget authority	-----	- 100	-----
Outlays	-----	- 76	- 24
Total			
Budget authority	2,334	2,217	1,671
Outlays	<u>2,131</u>	<u>2,241</u>	<u>1,858</u>

Type the
number of pages
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and indicate
the date

STANDARD FORM 300
For use, Bureau of the Budget
General Accounting Office, Washington,
D.C. 20540

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
SALARIES AND EXPENSES

Object Classification (in thousands of dollars)

Identification code	85 actual	86 estimate	87 estimate
11-2600-0-1-802			
Personnel compensation:			
11.1 Full-time permanent.....	592	671	671
11.3 Other than full-time permanent....	148	114	79
11.5 Other personnel compensation.....	34	15	5
11.8 Special personal services payments.....	584	568	198
11.9 Total personnel compensation....	1,358	1,368	953
12.1 Personnel benefits: Civilian....	84	82	82
21.0 Travel and transportation of persons.....	110	110	76
22.0 Transportation of things.....	4	2	3
23.1 Standard level user charges.....	433	473	365
23.3 Communications, utilities, and miscellaneous charges.....	217	145	97
24.0 Printing and reproduction.....	14	9	10
25.0 Other services.....	48	95	48
26.0 Supplies and materials.....	32	29	32
31.0 Equipment.....	---	4	5
99.9 Total obligations.....	2,300	2,317	1,671
	(Minor amt: \$1.0)	(Minor amt: \$)	(Minor amt: \$)

SS 58-910

67

STANDARD FORM 300
July 1964, Bureau of the Budget
Circular No. A-11, Revised.
5010-104

PERSONNEL SUMMARY

Identification code	#85 actual	#86 estimate	#87 estimate
11-2600-0-1-802			
Total number of full-time permanent positions.....	11	15	15
Total compensable workyears:			
Full-time equivalent employment.....	20	23	23
Full-time equivalent of overtime and holiday hours.....	1	1	1
(Reference cost: \$5.8)	(Reference cost: \$)	(Reference cost: \$)	(Reference cost: \$)

Form 300
8 pages, 22 lines
Use of
the information
Form 300

STANDARD FORM 300
July 1964, Bureau of the Budget
Circular No. A-42, Revised.
5010-104

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
SALARIES AND EXPENSES

REDUCTION PURSUANT TO PUBLIC LAW 99-177

Program and Financing (in thousands of dollars)

Identification code	85 actual	86 estimate	87 estimate
11-2600-6-1-802			
Program by activities:			
10.00 Total obligations.....	---	- 100	---
Financing:			
40.00 Budget authority (appropriation).....	---	- 100	---
Relation of obligations to outlays:			
71.00 Obligations incurred, net.....	---	- 100	---
72.40 Obligated balance, start of year.....	---	---	- 24
74.40 Obligated balance, end of year.....	---	24	---
90.00 Outlays.....	---	- 76	- 24
THESE REDUCTIONS ARE REQUIRED BY THE BALANCED BUDGET AND EMERGENCY DEFICIT CONTROL ACT OF 1985 (PUBLIC LAW 99-177).			
(Please omit: 85.0)	(Please omit: 8)	(Please omit: 8)	(Please omit: 4.0)

STANDARD FORM 306
July 1964, Bureau of the Budget
Circular No. 6-11, Revised
GPO: 1964-580-100

STANDARD FORM 306
July 1964, Bureau of the Budget
Circular No. 6-11, Revised
GPO: 1964-580-100

DETAIL OF PERMANENT POSITIONS

	19 85 actual	19 86 estimate	19 87 estimate
Executive Level II	1	1	1
Executive Level III	1	2	2
Subtotal	2	3	3
ES-6	2	3	3
ES-3	0	1	1
Subtotal	2	4	4
GS-12	2	2	2
GS-11	0	0	0
GS-10	2	2	2
GS-8	2	2	2
GS-7	1	2	2
Subtotal	7	8	8
Total permanent positions.....	11	15	15
Unfilled positions, end of year.....	4	---	---
Total permanent employment, end of year.....	11	15	15
(None met: 10.3)	(None met: 4.9)	(None met: 4.9)	(None met: 4)

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
ESTIMATES BY OBJECT CLASSIFICATION -- FY 1987

11 PERSONNEL COMPENSATION \$ 953,000

- 11.1 Permanent positions. Regular salaries and wages paid directly to civilian employees in full-time permanent positions without regard to type of appointment.....\$671,000.
- 11.3 Positions other than permanent. Regular salaries and wages paid directly to civilian employees in positions not included in full-time "permanent positions". This includes temporary and part-time employees and compensation for consultants.....\$79,000.
- 11.5 Other personnel compensation. All other personnel compensation paid directly to civilian employees, including premium pay and differentials. Costs incurred for employees who work overtime, Holidays, and Sundays fall under this category.....\$5,000.
- 11.8 Special personal services payments. Payments made to other agencies for services of civilian employees and military personnel on reimbursable detail (including related reimbursable amounts for personnel benefits).....\$198,000.

12 PERSONNEL BENEFITS \$ 82,000

Contributions for retirement; FICA; Medicare; life, hospital, Old-age Survivors and Disability insurance; and hospitalization benefits.

21 TRAVEL AND TRANSPORTATION OF PERSONS \$ 76,000

Attendance of OSTP staff members at conferences and meetings on science and technology affairs, both domestic and foreign; consultant and contractor travel; official taxi reimbursements.

22 TRANSPORTATION OF THINGS \$ 3,000

Contractual charges incurred for the transportation of things and for the care of such things while in process of being transported. Examples: Freight and express, trucking and other local transportation, and mail transportation.

23 SLUC, COMMUNICATIONS, UTILITIES AND OTHER RENT \$462,000

23.1 Standard level users charges (SLUC).
Charges for rental of space and related services assessed by the General Services Administration as standard level user charges (SLUC)\$365,000.

23.3 Communications, utilities, and miscellaneous charges. Charges for communications, utilities, and for rental of space, except SLUC. The OSTP incurs charges for the following items:

Charges for the transmission of messages, such as land telegraph services, and telephone and teletype service; postage, teletype equipment. Also includes charges for telephone installation; and telephone, switchboard, and maintenance services.....\$95,000.

Rental of reproduction machinery and equipment used to support the staff; maintenance of typewriters, office machines and equipment.
.....\$2,000.

24 PRINTING AND REPRODUCTION \$ 10,000

Charges incurred for printing and reproduction performed by the Government Printing Office. Also includes standard forms when specially printed or assembled to order, and printed envelopes and letterheads.

25 CONTRACTUAL AND OTHER SERVICES \$ 48,000

Reimbursement for access to Public Health Service facilities; building alterations to accommodate personnel and equipment; safe repairs; representation funds.

26 SUPPLIES AND MATERIALS \$ 32,000

Charges incurred for office supplies, subscriptions to newspapers and periodicals, pamphlets and documents, maps and charts.

31 EQUIPMENT \$ 5,000

Transportation equipment; furniture and fixtures; books for permanent collections; tools; purchase of new equipment to provide for a microcomputer-based interactive communications network.

TOTAL ESTIMATES\$1,671,000

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

JUSTIFICATION OF ESTIMATES -- FISCAL YEAR 1987

The \$1.671 million estimated OSTP budget for FY 87 shows a decrease of \$646,000 below the amount now appropriated for FY 86. This budget provides support for OSTP at a level consistent with the mission and current activities of the office. These activities continue to be tailored to a small permanent staff which is assisted by experts detailed on a contingency basis.

The Justification of Estimates follows:

* Personnel Compensation and Benefits -- \$1,035,000

There are no increases anticipated above the amount currently appropriated for FY 86. Of this total \$671,000 is for permanent positions.

We anticipate that \$198,000 will be expended for detailees in FY 87.

The OSTP will have fifty Consultants appointed to assist the staff when the need arises. Nineteen are compensated when actually employed (WAE); thirty-one serve without compensation (WOC). Eleven of the thirty-one Consultants serving without compensation serve with the White House Science Council. We estimate an expenditure of \$47,000 for consultants.

The Office also estimates the employment of two individuals in part-time/temporary positions. The costs associated with these individuals is \$32,000.

We estimate that payments of overtime and holiday hours worked by the support staff under the Other Personnel compensation category will be reduced by \$10,000. The costs associated with other personnel compensation is \$5,000.

The costs estimated for personnel benefits, other than detailees is \$82,000.

* Travel and Transportation -- \$76,000. A decrease of \$34,000 is estimated for FY 87. Staff members are required to attend conferences and meetings on science and technology affairs, both domestic and foreign. We will also have to expend travel funds for consultant travel and local transportation requirements of the staff.

* Transportation of Things -- \$3,000. An increase of \$1,000 over that currently appropriated for FY 86. Charges by common carrier and contract carriers such as Federal Express or a delivery service are incurred under this object classification.

The Office normally does not have a requirement for these services but on occasion it is necessary. The OSTP is serviced by the Office of Administration messenger service which also services other components of the Executive Office of the President. The staff also utilizes the Government Postal Express service. But on occasion time constraints require us to resort to these alternative services.

* Standard Level User Charges -- \$365,000. The OSTP has offices located in the Old Executive Office Building (OEOB) and the New Executive Office Building (NEOB). In FY 87 OSTP will realize a decrease from the amount currently appropriated for FY 86.

During FY 87 the OSTP will reduce the amount of office space assigned by 3,159 sq.ft. in the NEOB. The amount of occupied space is as follows:

OEOB 1,810 sq ft at \$26.73

NEOB 8,921 sq ft at \$29.75

Our total sq ft of office space is 10,371 sq. ft. for a total of \$313,781.

I have indicated the amount of office space which is occupied by the staff, but of course there are additional charges to the OSTP for joint space, general storage areas, food services, structural changes, etc., which are prorated to all occupying agencies within the Executive Offices of the President complex at differing rates. The estimate for FY 87 for areas other than office space is \$51,219. It is in these areas that OSTP received a decrease.

* Communications, Utilities, and Other Rent -- \$97,000. A decrease of \$47,000 is anticipated for FY 87 for charges incurred under this category. The decrease is because of a reduction in lease and maintenance charges for word processing equipment.

* Printing and Reproduction -- \$10,000. An increase of \$1,000 is anticipated for FY 87 for charges incurred for printing and reproduction performed by the Government Printing Office or other Government agencies.

* Contractual and Other Services -- \$48,000. A decrease of \$47,000 is anticipated from that currently appropriated for FY 86. The reduction is realized by a reduction in the amount of funds required for office maintenance and maintenance on Government-owned equipment.

No provisions have been made to let contractual studies.

Also, within this category is a total of \$1,500 for representation funds.

* Supplies and Materials -- \$32,000. An increase of \$3,000 is estimated for charges incurred for office supplies, subscriptions to newspapers and periodicals pamphlets and documents, maps and charts. The major expenditures in this category are caused by costs incurred for scientific and technical materials required to support the Director and his staff.

* Equipment -- \$5,000. An increase of \$1,000 is estimated for charges incurred for furniture and fixtures; books for permanent collections; equipment.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
SALARIES AND EXPENSES
SUMMARY OF OBLIGATIONS BY OBJECT

	<u>Actual</u> <u>FY 1985</u>	<u>Estimate</u> <u>FY 1986</u>	<u>Estimate</u> <u>FY 1987</u>	<u>Difference</u> <u>FY 1986/87</u> <u>(+)</u> <u>(-)</u>
				(Increase) (Decrease)
Permanent Staff				
Positions	11	15	15	0
PTE	20	23	23	0
<u>Personnel Compensation</u> (in thousands of dollars)				
Permanent Positions	592	671	671	0
Temporary Positions	79	64	32	- 32
Overtime, Holiday and Other	34	15	5	- 10
Consultant Compensation	69	50	47	- 3
Reimbursable Detail	<u>584</u>	<u>568</u>	<u>198</u>	<u>-370</u>
Subtotal	1,358	1,368	953	-415
<u>Personnel Benefits</u>	<u>84</u>	<u>82</u>	<u>82</u>	<u>0</u>
Subtotal, Personnel Comp & Benefits	1,442	1,450	1,035	-415
<u>Travel</u>				
Staff	105	105	71	- 34
Consultant	2	0	0	0
Local & miscellaneous	<u>3</u>	<u>5</u>	<u>5</u>	<u>0</u>
Subtotal	110	110	76	- 34

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987	Difference FY 1986/87 (+) (-)
				(Increase) (Decrease)
<u>Transportation of Things</u>	4	2	3	+ 1
<u>Rentals & Communications</u>				
Space Rental	433	473	365	-108
Equipment and Other Rentals	123	94	2	- 92
Telephone, Telegraph and Postage	94	51	95	+ 44
Subtotal	650	618	462	-156
<u>Printing & Reproduction</u>	14	9	10	+ 1
<u>Other Services</u>				
Administrative Expenses	46.5	93.5	46.5	- 47
Representation Fund	<u>1.5</u>	<u>1.5</u>	<u>1.5</u>	<u>0</u>
Subtotal	48	95	48	- 47
<u>Supplies & Materials</u>	32	29	32	+ 3
<u>Equipment</u>	<u>0</u>	<u>4</u>	<u>5</u>	<u>+ 1</u>
Total	2,300	2,317	1,671	-646

A SUMMARY OF ACCOMPLISHMENTS IN FY 1985 BY THE
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

The Reagan Administration's science and technology policy clearly defines the role of the federal government. Agencies responsible for the support of research and development carefully evaluate projects on the basis of excellence, relevance, and appropriateness. In an effort to maximize the return on the nation's investment in R&D to U.S. society, various R&D performers are encouraged to collaborate. The broad aim is to ensure that the U.S. continues to lead the world in research and technology, and maintains a competitive position in international markets.

Briefly, the Administration's policy and actions intend to increase the contribution of science and technology to the national goals of improved industrial competitiveness and a stronger national defense. This was reflected in the FY 1984 and FY 1985 federal budgets and will continue to be implemented in FY 1986.

The activities and accomplishments of the Office of Science and Technology Policy during fiscal year 1985 are summarized in the following pages.

SPECIFIC ACTIVITIES

FOLLOW-ON TO REVIEW OF FEDERAL LABORATORIES

At the request of Dr. Keyworth, a Panel of the White House Science Council conducted a review of the Federal laboratories to determine if the Nation is getting adequate return on its investment in these laboratories and to identify obstacles to successful performance by these laboratories. The Panel presented its recommendations to Dr. Keyworth in May 1983, and Panel Chairman David Packard presented the recommendations to the President and Cabinet in July. The recommendations were supported by the President, and a Presidential memorandum was issued in August 1983, directing OSTP and OMB to lead an interagency effort to respond to the recommendations. The memorandum also required OSTP and OMB to report progress to the President by July 1, 1984.

A FCCSET Committee was established to carry out this assignment. Its report, completed in June 1984, notes that in general, the agencies have been very responsive in implementing the White House Science Council's recommendations, especially when the agency head has been directly involved.

Perhaps the most pervasive impact of the Science Council's report has been a heightened awareness on the part of top management in Federal agencies of the need to focus on laboratories, both in terms of their output and their institutional needs. The appropriate management attention has brought about, and will continue to bring about, a variety of improvements. The FCCSET Committee also drafted proposed legislation to establish a separate personnel system for Federal scientists and engineers as recommended by the Packard Panel.

The Progress report was briefed in March 1985 to the Cabinet Council on Commerce and Trade, resulting in formation of a working group to recommend an Administration position on personnel legislation. The activities of that working group have been taken over by a new working group reporting to the Domestic Policy Council.

HEALTH OF UNIVERSITIES

At the request of Dr. Keyworth and under the co-chairmanship of Mr. David Packard and Dr. Allan Bromley, the White House Science Council has embarked on a study examining the health of the universities. Our nation's ability to compete successfully in world affairs depends on the continued development of new knowledge and an adequate supply of the very best scientific and technical talent. The support of basic research and the education of such talent have been major objectives of the Administration's science and technology policy. Because a substantial portion of basic research and a majority of the education of that talent is conducted within the university setting, the continuing health of our nation's universities is fundamental to this policy. There is concern that a number of specific long-standing problems now pose a risk to their future health and vitality. The continued strength and growth of our scientific enterprise depends upon the ability of the universities to attract and retain the best minds to do research and to teach in science, engineering, and medicine. Accordingly, the Panel is examining the principles underlying the relationships between the federal government, industry, and the universities and their impact upon university research. The Panel will provide a policy statement to serve as a guide to federal actions with respect to universities and colleges and their partnership with government and industry. The report will be released in the Spring 1986.

SCIENCE, MATHEMATICS, AND ENGINEERING EDUCATION

One of the Administration's initiatives proposed by OSTP to highlight the importance of precollege science and mathematics

education is the Presidential Award for Excellence in Science and Mathematics Teaching. The awards are presented annually to 104 science and mathematics teachers selected from across the nation - two from each state plus the District of Columbia and Puerto Rico. Not only do these awards focus national attention on the importance of precollege science and mathematics education, they also provide leverage in terms of increased local support and contributions from industry.

To remedy the shortage of college faculty in engineering and science, NSF is administering the Presidential Young Investigator Awards program, designed to induce outstanding young science and engineering faculty to remain in academia rather than leave for industry. This program calls for private sector participation, and industry has responded enthusiastically. The first two hundred awardees, selected from 1400 nominations, were announced in February 1984. Half of these were engineers. The awards are for five years. Another two hundred were awarded in February 1985.

INDIRECT COSTS

OSTP was requested by Congress, HHS and OMB to address the problem of rapidly increasing reimbursements for the indirect costs of university research. The problem appears to be not so much indirect costs as a whole, but the administrative components of indirect costs. These comprise over half of total indirect cost reimbursements, are rising faster than other components, and are the most difficult of the components of indirect costs to verify (even with audits). The White House Science Council's Panel on Health of Universities has explored solutions to this administrative cost problem in the context of the overall costs of doing federally funded research in the nation's university system. Specific policy recommendations to address this issue were outlined in a memorandum to the Secretary of Health and Human Services from the Director of OSTP. The White House Science Council's Panel Report on the Health of the Universities, to be released in Spring 1986 includes a similar recommendation to fix the administrative cost rate. In addition, the Panel recommends an increase in use charges to more accurately reflect current costs of facilities and equipment.

ENGINEERING RESEARCH CENTERS

NSF awarded grants in FY 85 establishing six Engineering Research Centers. The Six Centers are: University of California at Santa Barbara, Center for Robotic Systems and Microelectronics (\$1.17M); University of Delaware, Center for

Composite Manufacturing Science and Engineering (\$750K); Columbia University, Engineering Research Center for Telecommunications (\$2.2M); MIT, Biotechnology Process Engineering Center (\$2.2M); Furdue University, Research Center for Intelligent Manufacturing Systems (\$1.5M). The Engineering Research Center Program was conceived as a way to redress the mismatch that occurs between industry needs and university capabilities in the area of systems synthesis, which requires relatively large scale, cross disciplinary educational and research environments that schools of engineering are not generally equipped to provide. All six Centers are progressing exceptionally well and have attracted heavy industrial participation. NSF plans to continue the existing Centers and to establish 4 new Centers in FY 86.

SCIENCE JOB CANDIDATES

OSTP has worked closely with Presidential Personnel to identify highly qualified candidates for a range of top level science jobs. These have included all the Presidential appointments to the National Science Foundation, the National Science Board, and key positions in the National Aeronautics and Space Administration, Department of Energy, Department of Commerce and the Department of Defense. We have also helped select numerous committees, boards and commissions set up by the President or Congress and discussed separately.

TECHNOLOGY TRANSFER POLICY

OSTP was instrumental in obtaining interagency concurrence on a statement of Administration policy on the transfer of scientific and technical information. The draft national policy statement now under review in the National Security Council, establishes that the mechanism for the control of scientific and technological information produced in fundamental research at universities and laboratories, under contract to the U.S. government, will be classification. OSTP chaired an interagency working group on scientific communication, as a subcommittee to the Interagency Committee on Technical Data Controls, which is revising Section 379 of the Export Administration Act. As a result, this section is now consistent with the draft policy statement on the transfer of scientific and technical information. The constraints on the export of scientific and technical information either publicly available, or derived from fundamental research, are unambiguously spelled out for the first time.

OSTP has also assisted the National Security Council in redefining the President's policy on U.S. export controls.

Our principal activities involved the new U.S. export policy toward the People's Republic of China and the review of technology transfer requirements and policies formulated by government departments. As an example, we served a central role in coordinating government-wide activities to finalize technical guidelines for U.S. industry to use in the potential sale of a direct broadcast satellite to the People's Republic of China.

The National Policy Statement on the transfer of scientific and technical information has been reviewed and accepted by the National Science Council and signed by the President so that classification is the mechanism for control of such information.

CABINET COUNCIL ACTIVITIES

Agent Orange

OSTP is also an active participant in the Agent Orange Working Group (AOWG) of the Domestic Policy Council. The AOWG was established in 1981 and is charged with being the overall coordinator, clearinghouse, and evaluator of the Federal research effort on health issues surrounding the use of Agent Orange during the Vietnam Conflict. The major expenditures (\$155M) in Federally sponsored Agent Orange research over the past five years have been for ten major epidemiological studies and five health surveillance projects. These studies and projects have committed the Veterans Administration, and the Departments of Health and Human Services and Defense to long-term studies involving more than 50,000 Veterans of the Vietnam Era. Although no new major Federal epidemiological study results were released in 1985, the AOWG reviewed the results of two Australian Health Studies of Australian Vietnam Veterans and two studies by the State of New York of Vietnam Era veteran populations. These latest studies continue to support earlier results that no health effects in Vietnam Veterans or their families can be attributed to exposure to Agent Orange. A series of Federally sponsored major studies on mortality and rare cancers are nearing completion and are to be reported in early 1986. In addition, the Centers for Disease Control (CDC) of the Department of Health and Human Services will be releasing the results of the Vietnam Experience Study, a study of 12,000 Veterans, half of whom participated in military service in Vietnam during the years 1967-1969. The Congressionally-mandated Study (P.L. 96-151) involving combat ground troops exposed to Agent Orange has not

yet begun by CDC because of continued problems in identifying a sufficiently large cohort of exposed troops. Final action on this study is expected in March 1986.

Biotechnology

OSTP has chaired the Cabinet Council Working Group on Biotechnology since it was established in April 1984. Its primary objective is to coordinate federal activities in biotechnology. The first task was to identify the specifics of the regulatory milieu, to examine areas of existing overlapping jurisdiction, and to resolve jurisdictional issues for new concepts as they are explored. A second task was to design an advisory committee system to provide consistent scientific advice and risk assessment to the Federal agencies involved in supporting research and in regulating new products. A third task has been to study the federal research effort and to provide policy for its scope and direction. All of these tasks have been undertaken with the enhancement of the competitive position of U.S. research and industry and international cooperation as a clear objective.

The Working Group published the results of its deliberations on December 31, 1984, in the FEDERAL REGISTER for public comment. The notice included a matrix outlining the statutes, guidelines, and regulations affecting the research, development, manufacturing, transportation, use, and disposal of biotechnology products; policy statements by EPA, FDA, and USDA describing a general policy framework within which regulatory decisions will be made; a proposed advisory mechanism to provide scientific assessments to the agencies involved in regulation or research in biotechnology; and an interagency committee to foster timely and coordinated decision making on regulation and research priorities, to resolve jurisdiction issues, to consider international trade and regulation issues, to monitor the developments in biotechnology and recommend changes in regulations and legislation as the need arises.

In the reorganization of the Cabinet Council, the Working Group on Biotechnology now reports to the Domestic Policy Council, but it continues to be primarily concerned with policy issues relating to biotechnology.

As FY 1985 closed, the Working Group began to draft a new notice for the FEDERAL REGISTER to establish a Biotechnology Science Coordinating Committee (BSCC) in the Federal Coordinating Council for Science, Engineering and Technology, to revise mechanisms, and list statutes and regulations pertaining to biotechnology. It is anticipated that the BSCC will be a forum for coordinating scientific problems and issues, while the DPC Working Group will concentrate its concern on policy issues related to U.S. commercialization, international competitiveness, the Federal role in R&D and international cooperation on safety.

The DPC Working Group continued to analyze comments on the December 31, 1984 notice and foster cooperation between the regulatory agencies which would receive and review research and product applications.

The Biotechnology Working Group consists of representatives of the Departments of the Interior, State, Justice, Agriculture, Defense, Commerce, Energy, Health and Human Services, Labor, the Environmental Protection Agency, the Council on Environmental Quality, the Council of Economic Advisors, the Office of Management and Budget, the Office of Policy Development, the Office of Science and Technology Policy, and the National Science Foundation. The agencies and departments involved in regulation, including EPA, FDA, and USDA, are major participants in this working group.

Risk Assessment and Risk Management

OSTP is co-chairing with NSF an interagency initiative to examine the scientific data which underlies the assumptions used in the risk assessment process. The Federal agencies have provided to OSTP and NSF the most important assumptions they each use. The goal is to produce a document which will present the data and describe the strengths and weaknesses of the science upon which the assumptions are based. To date, 14 assumptions of highest concern to the Agencies have been identified. NSF has contracted with Oak Ridge National Laboratory for the preparation of a serious scientifically defensible draft reports on these assumptions. These documents, to be completed in late 1986, will be reviewed by a balanced panel of respected experts and will be submitted to a series of consensus-building workshops that will involve experts within and outside of government. The final report should provide regulatory agencies with guidance on the conduct of risk assessment.

With NSF, OSTP has initiated a second interagency project that was intended to facilitate the issue of communicating

risk management decisions to the public. All Federal agencies which are called upon to interface with the public over health and environmental hazards have formed a steering committee under the leadership of NSF to oversee the production of training materials to be used in programs designed to increase agency personnel sensitivities to the needs of the public to understand the information and options available in decisions involving acceptance or alleviation of risk. The product will be generic training materials that can be adapted by the agencies to meet the particular needs of their situations.

Space Initiatives

OSTP participated in the Economic Policy Council Working Group on Commercial Space Initiatives. This group was established by the National Space Strategy to develop and implement specific measures to foster the growth of private sector commercialization in space. The working group examined a range of policy concerns which affect commercial space activities (e.g. antitrust, tax laws, patent laws, and industry-government relationships) and forwarded a report to the Economic Policy Council which identified several areas appropriate for further consideration and action by the working group. The result of the report will be the establishment of a working agenda for the group during 1986.

OSTP participated in the Cabinet Council on Commerce and Trade Working Group on Commercial Space Initiatives. This group reviewed the report of the Commercial Space Group and provided recommendations for the changes in areas such as tax laws and regulations, research and development programs, laws and regulations for space operations, and industry-government agreements.

FEDERAL COORDINATION COUNCIL ON SCIENCE, ENGINEERING AND TECHNOLOGY

The FCCSET was established by P.L. 94-282 to deal with science and technology policy issues affecting more than one Federal agency. It is chaired by the Director, OSTP. During FY 1985 the active committees were:

- Atmosphere and Oceans
- Federal Laboratories
- Food, Agriculture, and Forestry Research
- Human Subjects
- Intellectual Property
- Materials
- Ocean Pollution

Radiation Policy
Solar-Terrestrial Research
Supercomputers

A committee on International Science Engineering and Technology (CISET) has been reestablished to provide a senior level inter-agency mechanism to identify, coordinate and evaluate science and technology issues and programs with significant international implications.

RADIATION RESEARCH AND POLICY COORDINATION

The FCCSET Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) in its first year of operation has provided a unique and effective mechanism to coalesce policy guidance to federal agencies on several national issues of major concern; to help define national radiation issues of concern to member agencies, Congress, and other segments of society; and to represent, as appropriate, the Executive Branch with Congress.

On January 25, 1985, Dr. Keyworth forwarded to HHS, the CIRRPC Report on the draft Report of the National Institutes of Health Ad Hoc Working Group to Develop Radioepidemiological Tables. In its report, CIRRPC concludes that the "report of the Ad Hoc Working Group is an excellent and scientifically responsible document which provides probabilities of causation (PC) on the basis of the current knowledge on radiation carcinogenesis in man." However, the Committee went on to observe "that there are several aspects of the report that require attention to define more clearly the limitation of the tables. An improved discussion of the uncertainties inherent to the PC calculation, and guidance concerning application of the radioepidemiological tables to high LET radiations and internally deposited radionuclides are particularly important." In subsequent testimony before Senate Hearings, OSTP noted that there are far-reaching consequences of the application of the Tables which touch virtually all of the CIRRPC member agencies. The testimony expressed caution on their application and recommended further refinement, research, and reduction of the uncertainties in their calculations. A CIRRPC policy subpanel has now been established to consider potential impacts on federal activities and responsibilities resulting from using the Radioepidemiological Tables in injury compensation cases.

During 1985, the CIRRPC Executive Committee held a series of meetings with senior staff of each of the eighteen member agencies. Specific matters affecting agencies' programs have been brought to light, problem areas identified, and invaluable insight gained into the major issues affecting federal government operations upon which CIRRPC must focus its attention.

CIRRPC has brought together some of the most qualified scientific talent in the federal government in the area of radiation health effects to assist in formulating federal policy on radiation matters. To date, two important issues have been so addressed (the Radioepidemiological Tables, and a critique of a proposed Atomic Veterans Study) and efforts begun to address other complex policy and scientific issues, including radon, non-ionizing radiation, food irradiation, and the standardization of radiation protection standards.

Not immediately apparent is the equally important impact CIRRPC has had on the ability of the federal agencies to manage radiation research. This has been brought about by valuable and productive dialogue at the senior policy and senior scientific levels, and a focusing within each member agency on those issues of special interest. Not since the Federal Radiation Council has the level of interagency communication on radiation matters been as effective or has the Executive Branch had available the consensus of top government scientists on which to base well-informed policy positions.

CARCINOGEN DOCUMENT

Following a three year development period, and extensive public and peer review, OSTP published in final form in the March 14, 1985 issues of the FEDERAL REGISTER its document "Chemical Carcinogens, A Review of the Science and Its Associated Principles." The document was developed by 20 senior scientists from all Federal government research and regulatory agencies with an interest in chemical carcinogenesis. The 31 Carcinogenicity Principles contained in the report, together with a more detailed description of the basic science "can serve as the basis for consistent regulatory cancer guidelines that the Federal agencies can tailor to meet the requirements of the legislative acts they are charged to implement." This is the first cancer policy of this stature published by the Federal government.

The Principles generally reflect the positions held by the scientific community. The document provides direction for the incorporation of current scientific understanding into regulatory agency risk assessments. However, since the Principles are quite general and are not written in "thou shalt" and "thou shalt not" language, the Principles alone will not ensure that the best scientific understanding will be used in agency risk assessments. More detailed guidelines developed by each agency, together with their implementation on a chemical-by-chemical basis, will continue to be required where important issues are to be resolved. OSTP has

encouraged and is following the adoption of the document by all Federal agencies that have regulatory responsibilities for carcinogens.

WHITE HOUSE WORKING GROUP ON HEALTH POLICY AND ECONOMICS

OSTP is participating in a White House Working Group on Health Policy and Economics which is examining the many elements which are involved in the expansion and increased cost of the health care enterprise in this country. This is an interagency policy group which examines issues such as third-party payment of health bills by Medicaid, Medicare, and private insurers; the impact of various models of health insurance on health care cost; the role of tax laws and tax incentives on health care cost; high technology and new developments in biomedical research as they relate to delivery of medical care; the consideration of catastrophic health insurance; and recent efforts on the part of the Federal Government to slow down the cost of health care such as diagnosis-related groups (DRGs), proposed tax incentives, caps on physician's fees, and technology assessment policies. It is expected the specific policy recommendations will be made through the Office of Policy Development within the next four to six months.

MODEL POLICY FOR THE PROTECTION OF HUMAN SUBJECTS

In its first biennial report published in December 1983, the President's Commission for the Study of Ethical Problems in Medicine in Biomedical and Behavioral Research made several recommendations intending to improve the uniformity of Federal rules and policies pertaining to the protection of human subjects. As a direct outgrowth of the Commission's report, OSTP chartered a FCCSET committee for the protection of human subjects, chaired by the Assistant Secretary for Health in the Department of Health and Human Services. This ad hoc committee is comprised of representatives from 17 departments and agencies who are involved in any way in research on human subjects. The ad hoc committee drafted a policy to serve as a model for all Federal departments and agencies that conduct, support, or regulate human subjects research. This policy reflects the different statutes, policies, and practices of the various agencies involved. In its present form it represents an excellent model for use by each agency. The policy is currently in final review by OMB. The model policy, along with indications of approval and necessary departures by specific departments and agencies, will be published in the FEDERAL REGISTER for public comment.

In recognition of the concerns of the Assistant Secretary for Special Education and Rehabilitative Services at the Department of Education, the ad hoc committee has established a subgroup to study and make recommendations for any special protection that should be provided for the mentally impaired.

Additionally, the ad hoc committee also responded to the President's Commission's call to authorize and direct the Secretary of Health and Human Services to designate an office with government-wide jurisdiction to coordinate, monitor, and evaluate the implementation of all regulations governing research with human subjects. In response to this request, the ad hoc committee has recommended the designation of the Office for Protection from Research Risks to serve in a coordinating capacity with the advice of a proposed Interagency Human Subjects Coordinating Committee (IHSCC) composed of representatives from all involved federal departments and agencies. This interagency coordinating committee will provide coordination and communication as well as full-time focus on issues relevant to research on human subjects but will allow final decision-making to reside in each department and agency.

MODEL POLICY FOR RESEARCH INVOLVING ANIMALS

With the experience of the Model Policy for Human Research and with the concern that there be adequate protection and guidance for animals used in research, an interagency committee was established in 1983 and was immediately tasked by OSTP to draft a set of guiding principles regarding the use of animals for biomedical purposes. These principles would serve as a guideline for all federal agencies and departments supporting such research.

OSTP published in the May 20, 1985 issue of the FEDERAL REGISTER "U.S. Government Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research, and Training." Effective June 1, 1985, all Federal government agencies which either use or require the use of experimental animals have incorporated the principles into their animal use policies. The nine principles included in the agreement cover the areas of proper transportation, care and use of animals in accordance with relevant laws and policies; good design and performance of worthwhile projects; use of appropriate species, quality and number of animals; avoidance of discomfort, distress and pain when consistent with sound scientific practice; use of sedation, analgesia or anesthesia when appropriate; euthanasia to avoid severe or chronic pain; proper living conditions and veterinary care; use of qualified animal care personnel; and procedures for seeking any exception needed for scientific reasons. OSTP will continue to work with the

Interagency Research Animal Committee to insure the implementation of these principle and to supplement them with more detailed guidelines where appropriate.

AGRICULTURAL RESEARCH

The challenges facing research and education in the food and agricultural sciences have never been greater. The knowledge of molecular genetics and cellular biology is increasing rapidly and the use of genetic manipulation and other "tools" of biotechnology will revolutionize agriculture. Clearly, the less than 1.8 percent annual growth rate in real dollar levels of public investment in agricultural research since 1967 has had a detrimental impact on the ability of the U.S. to maintain its internationally competitive edge in the Agricultural industry and to provide for a strong domestic agricultural community.

Accordingly during 1985, OSTP through its participation in the USDA Joint Council on Food and Agricultural Sciences, and as a member of the Policy Advisory Committee to the USDA Office of Grants and Program Systems, is influencing priority setting and budget re-investment for research. OSTP has critically reviewed the current programs of the USDA research agencies with the intent of reassessing budget requirements especially as they apply to the plant sciences. Currently, the FY 86 USDA R&D budget (for Science and Education) is \$1.145B including \$42.3M for the Competitive Grants Program.

EARTHQUAKE ENGINEERING EXPERIMENTAL FACILITIES

OSTP requested the National Academy of Sciences to review recent studies of U.S. earthquake engineering research programs and to recommend priorities for earthquake engineering research facilities and instrumentation. In particular, the group was asked to examine the relative need for a national experimental facility (e.g. a very large "shake table") particularly in light of recent developments in computer simulation. The study was funded by FEMA as part of its overall emergency preparedness responsibilities. The group reported back in June 1984 with a series of recommendations. Their principal recommendation was to improve existing university earthquake engineering research and education capabilities. A program to define options for a facility capable of testing full scale structures and structural components and to plan for developing such a facility was also recommended. This report provides the earthquake engineering research community's priorities.

ARCTIC RESEARCH

In 1984, Congress passed legislation under which the President established the Arctic Research Commission whose purpose is to establish and implement (via an Interagency Arctic Research Policy Committee) a national Arctic research program plan. OSTP has worked with both the Commission and the Interagency Committee to develop the first plan and ensure agency and Commission efforts are consistent with Administration policy.

COMMITTEE ON ATMOSPHERE AND OCEANS

In November 1985, Dr. Keyworth renewed for another five years, the charter of the FCCSET Committee on Atmosphere and Oceans and reaffirmed Chairmanship by the Administrator of NOAA.

MATERIALS

OSTP has continued to lead the Interagency Committee on Materials (COMAT) during the past year. The 20-agency COMAT was established in June 1982 as a result of the President's National Materials and Minerals Program Plan of April 1982. COMAT working groups have continued to focus on federal materials research programs to improve interagency coordination and relevance to national needs. Of specific note is the progress of COMAT's Welding Technology Group in establishing the American Welding Institute, which is to be privately supported and will serve as a focal point for cooperative welding research efforts.

ENERGY

It is becoming obvious that a strong and growing economy requires an abundant and reliable supply of electrical generating capacity. There is no immediate need, but this Nation will likely reach a point of requiring more base load electricity by the early 1990s. Though coal will be the prime source of fuel for new large generating plants, nuclear power must play a major role in the electrical supply for the coming decades.

OSTP has been working closely with the Department of Energy to restore nuclear energy as a viable option. The utilization of high technology on the current designs of nuclear power plants and the support of industry, primarily through the Institute of Nuclear Power Operations (INPO), is allowing DoE to research new or improved reactor concepts for the 1990s.

Public confidence must be gained in the construction and operation of nuclear power plants. This Office is working closely with DoE and NRC to ensure that happens.

INTERNATIONAL SCIENCE

OSTP continues to coordinate and implement the President's policy and priority programs in international science and technology cooperation. In selected areas, OSTP develops new or revised Administration policies and initiatives in the international arena.

The significance of the international dimensions of science and technology to economic and research competitiveness and to U.S. foreign policy and national security interests has become increasingly more apparent in recent years. One factor is the number and importance of international S&T issues, research activities, and programs that cut across federal departments and agencies. Accordingly, in December 1985, the President's Science Advisor directed and chartered the establishment of the Committee on International Science, Engineering, and Technology (CISET) under FCCSET. CISET's purpose is to bring high-level scientific and technical expertise and responsibility in the government to bear on critical international issues and integrate international S&T activities into the framework of domestic R&D policy, consistent with the Administration's priorities and budgetary resources. CISET, chaired by OSTP, will be inaugurated in early 1986 and will ensure that senior policymakers oversee key international S&T issues and activities.

As one of the highest priority international science programs of the government, US-China science and technology agreements and cooperative activities continue to be monitored closely by OSTP. The fourth meeting of the US-PRC Joint Commission on Science and Technology took place in Washington in April. The highly successful meeting was co-chaired by Dr. Keyworth and his PRC counterpart, Dr. Song Jian. Two new protocols were signed at the meeting, one on mapping and charting and one on fossil energy. In addition, several existing agreements were extended during the course of the year, bringing to 25 the number of active protocols now being carried out under the umbrella S&T agreement initiated in 1978. Discussions are currently being held on additional agreements in the areas of space science and technology, telecommunications, hydraulic engineering and health. The hydraulic engineering agreement would replace and redirect the hydropower agreement which has been the only protocol singled out for non-renewal after both sides agreed it was no longer beneficial.

The Presidential Science and Technology Initiative (STI) established by President Reagan and Prime Minister Indira Gandhi in July 1982, was designed to elevate and sharply focus bilateral science and technology cooperation to improve the overall relationship between the United States and India.

An objective of the STI has been to invest shared resources in those selected research programs that would utilize the complementary expertise and accomplishments of both scientific communities. This partnership-investment approach to scientific cooperation was initiated in 1983 with joint activities established in the priority areas of health, agriculture, and monsoon prediction. In Spring 1985, the fourth research area of photovoltaics was redirected to encompass solid state science and engineering. OSTP continues to provide overall policy guidance for the STI and NSF, as Executive Agent, coordinates program activities on a government-wide basis. The National Academy of Sciences Review Panel has submitted a preliminary evaluation of the first phase of research conducted under the STI activities, and the final joint report will be presented in 1986. The first phase of research conducted under the STI has been notably successful. In recognition of its success as a fast track, high calibre program, the two governments agreed to renew the STI for an additional three years on the occasion of Prime Minister Rajiv Gandhi's visit to Washington in June 1985. Also, in connection with the Prime Minister's visit, Dr. Keyworth sponsored a scientific program for Gandhi at the National Academy of Sciences, highlighted by presentations on cutting-edge developments in biotechnology, precision robotics, information technology, and biomass conversion. In October 1985, the STI entered its second phase of operations, and new programs in solid state science and engineering were inaugurated. During this second phase, OSTP will closely monitor the monsoon program, to ensure that all program commitments are fully implemented.

The Science Advisor served as the U.S. representative to a Working Group of the Versailles Economic Summit. This group was established to consider the opportunities, problems, and challenges presented by technology, economic growth, and employment. The work of this group resulted in the publication in 1983 of the report, Technology Growth and Employment, which, among other things, identified eighteen projects for international cooperation. The U.S. has been lead or co-lead for six of the projects and an active participant in six others. At the May 1985 Bonn Economic Summit, the Heads of State endorsed the new report of the Working Group and the progress reported in carrying out the projects. A proposed review of the projects with a view toward their continuation in other international fora or termination, if appropriate, was also

endorsed, with the request for a report of the review in 1986. The Heads of State also asked that, with respect to the special environmental report prepared for the Summit, the Working Group follow-up on its conclusions and consult with appropriate international bodies about the most efficient ways for achieving progress in this field. The Working Group's 1985 report to the Tokyo Summit is completed. It provides for the TG&E Working Group to end its activities until called upon by Summit leaders in the future. It also provides for the eighteen projects to end their activities or continue outside the Summit umbrella. OSTP provides overall policy guidance and coordinates U.S. participation in all Working Group project areas and also plays the leadership role in formulating U.S. objectives and positions on S&T issues within the Summit context.

Separate from the Summit forum, but historically related to it, has been a series of informal conferences on bioethics. Originally proposed by Prime Minister Nakasone, the first conference was held in Japan in 1984. A second conference in 1985 was hosted by President Mitterand in France. As in the 1984 conference, OSTP selected the participants who represented the U.S. as private individuals expressing their own views in a wide ranging discussion of the ethics associated with new developments in the life science disciplines. A third conference is planned for Bonn in 1986 and OSTP is in the process of selecting participants from the neurosciences field.

In April, the Science Advisor participated in a Ministerial Conference hosted by Prime Minister Craxi of Italy on "Technology Innovation and the Creation of New Job Possibilities" and delivered the U.S. response to European statements. The Science Advisor articulated to European and OECD policymakers the Administration's views on the key role of S&T in economic growth and the positive link between the introduction of new, high technologies and employment opportunities in industrial nations.

Dr. Keyworth proposed an informal meeting of S&T ministers from key nations to discuss their common problems and experiences. This meeting was hosted by the Canadians in October 1985 and attended by science ministers or their equivalent counterparts from the U.S., UK, FRG, Italy, Canada, Japan and Australia. No formal records were kept in order to promote the informal nature of the meeting, and most participants expressed an interest in similar meetings for the future.

During 1985, OSTP has continued efforts to refocus the United States' science and technology cooperation with Japan to reflect Japan's role as a world class S&T player and away from joint activities that encompass "development" objectives.

OSTP endorses US-Japan cooperation in long-term, high-risk, and macro projects of high priority to advanced industrial nations, such as fusion, fast breeder reactors, high energy physics, robotics, and advanced manufacturing engineering. In March 1985, the White House Science Council and the Japan Council for Science and Technology convened for a special meeting to exchange views on S&T policy issues and explore potential areas for future collaboration. In 1986, OSTP will focus ongoing assessments of the US-Japan science and technology under the auspices of the Committee on International Science, Engineering, and Technology (CISET), recently chartered under FCCSET, and examine policy options to direct future US-Japan S&T relations.

During 1985, OSTP monitored US-Soviet S&T cooperation under the seven existing bilateral agreements and conducted an internal evaluation of S&T policy for interactions with the Soviets as well as the effectiveness of current U.S. Government coordination mechanisms. OSTP actively participated in the S&T issues associated with the President's meeting in Geneva with Secretary Gorbachev, including the joint decision to increase multilateral cooperation in fusion research. The changing environment of improved US-Soviet relations and the President's agreement in Geneva to expand bilateral contacts in many areas, including science and technology, calls for an integrated policy to underpin our technical agency programs to achieve national goals and protect security interests. Towards this end, the President's Science Advisor has established a sub-Cabinet level working group on "S&T policy and priorities for cooperation with the USSR and Eastern Europe," under the new FCCSET Committee on International Science (CISET). During 1986, this interagency working group will be charged with developing national S&T priorities and policy for future cooperation with the Soviets and assessing technical oversight mechanisms.

OSTP participated in the International Political Committee established to monitor the UNESCO reform process and develop U.S. alternatives to UNESCO activities in education, cultural, and scientific arenas. Such alternative activities will be designed to directly benefit U.S. interests and also to provide bilateral assistance to UNESCO-type programs that will benefit developing nations.

In compliance with Title V of the Foreign Relations Authorization Act of 1979, OSTP transmitted in early 1985 the President's 1985 Report on Science, Technology, and American Diplomacy to Congress which reports on U.S. Government policies and activities in international science and technology as an adjunct to U.S. foreign policy objectives. OSTP prepared the President's Transmittal Letter to the Congress which serves as a key statement of the Administration's policies and thrusts in international science. Similar actions are being taken for the 1986 Title V Report.

SPACE SCIENCE

The President's directive on National Space Strategy directs the agencies to maintain a vigorous and balanced program in the space sciences. OSTP reviewed the funding trends in NASA's Office of Space Science and Applications and issued a report in September 1984 recommending major efforts to reduce the large budgetary fluctuations among the space science disciplines, greater emphasis on long-range (10-year) planning, and enhanced funding and stability in the non-flight research base. OSTP has worked closely with NASA and OMB to address these issues and substantial programs have been achieved.

The National Space Strategy directs NASA to explicitly factor the broad spectrum of capabilities necessary for space science into the planning and development of the manned Space Station. OSTP has worked closely with the scientific community, the NASA advisory committees, and the NASA Space Station Office to carry forward this directive. The March 1985 recommendations of the NASA advisory committee on Space Science Objectives for Space Station has been reviewed by OSTP and NASA and is being fully considered for implementation by the Space Station Office.

The FCCSET Interagency Coordinating Committee on Solar Terrestrial Research was established in 1984 and began meeting on a regular basis in 1985. This committee is coordinating, reviewing, and enhancing the Federal Solar Terrestrial research programs, including agency plans for international cooperation. Due to the planned increased activities of man in space, particular attention was given to space research areas needed to improve the understanding of the sun and its effects on the near-Earth space environment. The committee recommended to NOAA that they maintain their research capabilities to provide appropriate monitoring and forecasting of the dynamic space environment.

The advent of space technology and use of large-scale computers for global modeling have provided the basis for an explosive growth in the capabilities and scientific impact of research in the earth sciences and a concomitant growth in the participation of various federal agencies in earth science research. Consequently, OSTP initiated a review of the roles and missions of the various federal agencies in the area of earth science research in the civil space program. This review defines agency roles, assesses the need for improved coordination and planning, and identifies actions required to improve the ability of earth science research from space to meet national needs. A report on this effort was completed in 1985.

NATIONAL MEDAL OF SCIENCE

OSTP was responsible for staffing and implementing recommendations by the President's Committee on the National Medal of Science. Nineteen medals were awarded in FY 1985. The President has approved the twenty nominations for 1986. An awards ceremony is planned for the Spring of 1986.

ANNUAL SCIENCE AND TECHNOLOGY REPORT

OSTP prepared the Annual Science and Technology Report for 1983/1984 from the President to Congress. The report will be widely distributed. As in the 1982 edition, the report describes the Administration's science and technology policy, the link between that policy and the FY 1985 Federal R&D budget, and Federal R&D accomplishments in 1983 and 1984.

AERONAUTICS POLICY

The national aeronautics policy was developed during 1982 in an interagency process chaired by OSTP. This approved national policy establishes the importance of aeronautical systems for America's national security and commercial competitiveness. In addition, the policy reasserted the U.S. Government's role in supporting aeronautical research and technology (R&T).

After subsequent assessment of current and proposed Government programs in aeronautical research by the OSTP sponsored Aeronautical Policy Review Committee, a series of National goals was established in 1985 which would fulfill the policy objectives. The goals are directed towards attaining specific aeronautical capabilities phased over the period through the turn of the century. Included are a subsonics goal to establish a firm U.S. aeronautical leadership into the next century; a supersonics goal to develop technology for efficient, long-distant supersonic cruise; and, a transatmospherics goal to exploit the growing convergence of aeronautics and space technology. Collectively, these goals will focus Government, industry, and university efforts and opportunities that are vital for the future success and leadership of America.

Recently the committee has been developing a sequel to the R&D Goals Report to define specific implementation steps for government and industry toward achieving these goals. It is anticipated that this report will be released in the spring of 1986. Additionally, the Office is working closely with government agencies, the academic and research communities, along with the industrial sector on the implementation of

the goals. Special emphasis is being placed on the pursuit of the DOD/NASA sponsored activity for a Transatmospheric Vehicle, the National Aerospace Plane program.

COMPETITIVENESS IN NATIONAL SECURITY ARENA

OSTP is conducting an analysis of scientific and technological competition between the Soviet Union and the U.S. in the national security arena. This effort is based on the premise that maintaining a strong United States science base and the effective focusing of this base toward key national security issues would have the potential to leapfrog current Soviet capabilities in the defense arena. This study has focused on specifically defining the national defense problem and quantitatively measuring the United States position relative to the Soviet Union in terms of national doctrine, defense budgets, military and political intent, survivability, weapon systems development and capability, and fielded weapons systems. It also addresses the science base from which each country operates and how this base relates to the national defense posture of the Soviet Union and the US respectively. An evolving conclusion from the study would be that the United States holds a clear technological edge on foreign competition and that this is a key element of the overall solution set that has not at this time been fully exploited. The study could form the foundation for policy dealing with technology leverage for national security.

NATIONAL AIRSPACE SYSTEM PLAN

OSTP has continued to work with the FAA and the DoT on the development of the updated National Airspace System. In particular, the 1982 recommendations of the White House Science Council concerning the systems integration requirements were reassessed and recommended changes submitted to the FAA Administrator. Currently under review is the long-term growth capability of the proposed system which could accommodate advances in aircraft systems expected to arise through the end of the century as a result of achieving the National Goals for aeronautical research.

OSTP is also reviewing the FAA and DoD interface and implementation process.

NATIONAL COMMISSION ON SPACE

OSTP worked with the Congress and later with Presidential Personnel to create the National Commission on Space (Public

Law 98-361). The Commission "shall study existing and proposed U.S. space activities; formulate an agenda for the U.S. civilian space program; and identify long-range goals, opportunities, and policy options for civilian space activity for the next twenty years."

SPACE POLICY FORMULATION PROCESS

The Office of Science and Technology Policy has played a key role in the formulation of the National Space Strategy in accordance with the National Space Policy. The strategy identifies high priority efforts and responsibilities, and provides implementation plans for major space policy objectives. OSTP participated in the Senior Interagency Group (SIG), Cabinet Council and their affiliated Working Groups on implementing top priority initiatives including establishing a National Commission on Space, the formulation of a shuttle launch pricing policy and further development of the U.S. space science program.

OSTP was a major participant in the establishment of a National Commission on Space to identify goals, opportunities, and policy options for United States civilian space activity for the next twenty years. OSTP was instrumental in establishing the framework within which the Commission would work and played a central role in identifying nominees for the Commission. OSTP was selected as the Executive Branch liaison to the Commission.

OSTP also actively worked on the issue of shuttle pricing which concerns the future flight costs for commercial and foreign payloads, the commercialization of expendable launch vehicles, and, more generally, the ability to maintain the preeminence of the shuttle as a national asset in both the commercial and national security arenas. OSTP made significant policy and technical contributions while participating in both an OMB-led study to evaluate different pricing policy options and a Cabinet Council Working Group on Commerce and Trade which assessed U.S. competitiveness for launch services. The recommendations resulting from these studies were inputs to the Presidential decision to institute auction pricing for Shuttle flights occurring after FY 1988.

STRATEGIC DEFENSE INITIATIVE

The Strategic Defense Initiative (SDI) is the operational embodiment of President Reagan's March 23, 1983 call for a search "for ways to reduce the danger of nuclear war" with the ultimate goal of rendering the ICBM "impotent and obsolete" as

a strategic weapon. The SDI is thus a research effort into the tools needed to effect a fundamental transformation of the strategic environment from an offensive reliant to a defensive reliant National security strategy.

To help implement the goal set by the President, the Office of Science and Technology Policy has worked closely with the Secretary of Defense in developing the overall program for the President's Strategic Defense Initiative. A policy was established which provided for the centralized SDI authority reporting directly to the Secretary of Defense, the streamlined procurement authority directed by the President, and the simplified five-element program management plan through which the President's SDI program is now executed. Additionally, OSTP interacts regularly with other agencies and organizations. OSTP advises OMB on priorities in SDI-related budgets; it provides science and technology policy advice to the National Security Council (NSC); it regularly consults with DoD on overall SDI program technology priorities and objectives, on allied participation and on technical evaluations; and it maintains a keen awareness of emerging technologies in industry and National laboratories. OSTP has participated in the interagency process to develop guidance, related to SDI, for our arms control negotiations in Geneva. OSTP has participated in many international fora to promote the understanding of allies on the SDI program. It has played a key role in discussions with allied leaders on the technology aspects of the program as well as the opportunities for cooperation. OSTP has been a strong proponent within the Administration for allied participation and has played a major role to facilitate cooperation.

DEFENSE AND SPACE POLICY DEVELOPMENT

OSTP has actively participated in the Defense and Space Interagency Group (IG), working group and backstop teams to ensure that the U.S. arms control delegation in Geneva understands and actuates the Administration's policies during the negotiations.

CONVENTIONAL FORCE ENHANCEMENT INITIATIVE

In his March 23, 1983 speech, the President indicated the technologies were at hand to enhance the effectiveness of the conventional forces and thereby raise the nuclear warfare threshold. Throughout this past fiscal year OSTP has worked closely with the Assistant Under Secretary of Defense for Conventional Initiative to implement the President's goals in this area. In meetings with the Commander of NATO and a

variety of allied and American field commanders, OSTP strengthened appreciation of how technology could be applied to meet military requirements of NATO.

OSTP established informal technology working groups with the United Kingdom and Germany in order to facilitate the efficient and effective use of our collective resources. These working groups will identify key technologies and recommend potential cooperative programs that will lessen the risk of a conventional conflict escalating to nuclear war.

An interagency group was established at the request of OSTP which will facilitate the application of SDI technology to conventional weapons development. The application of these SDI technologies could greatly enhance our conventional capabilities and thereby the unity of the NATO alliance while at the same time increasing our return on the research investment for SDI. Mechanisms will be developed during the upcoming year that will identify likely dual use or cross over technologies and transfer them to appropriate R&D establishments in the military departments for systems development.

OSTP, in conjunction with the Department of Defense, is sponsoring a technology impact study. The purpose of the study is to better understand the potential effect that the use of high leverage technologies, such as "super smart" munitions and advanced sensors, will have on U.S. ability to counter the growing Soviet conventional threat. The results from the study will be used to identify appropriate systems development priorities.

TELECOMMUNICATIONS POLICY

On April 3, 1984, the President signed Executive Order 12472, Assignment of National Security and Emergency Preparedness Telecommunications Functions. OSTP was a principal contributor to the policy formulation process which led to this order. This order provides for the consolidation of assignment and responsibility for improved execution of national security and emergency preparedness functions. In accordance with the Executive Order, the Director of OSTP acting in his capacity as Chairman of the Joint Telecommunications Resources Board (JTRB) convened its first meeting with representatives from the FCC, GSA, FEMA, NCS, NSC, DoD, NTIA, and OSTP to review and approve JTRB Standard operating procedures. OSTP will remain a reviewer and coordinator of all proposed telecommunications standards in keeping with the Director's emergency telecommunications resource management responsibilities for the President.

EMERGENCY PREPAREDNESS PLANNING

The Office of Science and Technology Policy has been deeply involved in emergency preparedness planning. OSTP worked closely with the Department of Commerce to develop and distribute an Emergency Readiness Plan for the use of the Radio Spectrum in times of National crisis. The Office holds membership on a variety of working groups and interagency groups for many emergency preparedness planning functions including earthquakes and telecommunications. Special emphasis has been placed on the functions related to the continuation of government.

NUCLEAR WINTER

Consistent with the 1984 recommendations of the special inter-agency policy group, the Office of Science and Technology Policy established a coordinated interagency research program designed to reduce uncertainties related to atmosphere parametric estimates associated with nuclear war. This coordinating committee chaired by OSTP was established to provide recommendations for specific studies and for coordination of research activities. Agencies represented on the committee include the Department of Defense (DoD), Department of Energy (DoE), National Science Foundation (NSF), Department of Commerce (DoC) and Office of Science and Technology Policy (OSTP). An integrated scientific research effort of \$5.75M for FY 87 is planned.

TECHNOLOGY FOR COUNTERTERRORISM

OSTP is working closely with OMB, the State Department, and the NSC Staff in the application of technology to counterterrorism. The purpose of this effort is to identify promising technologies and to coordinate their development to ensure that our national research and development resources are used to their maximum effectiveness. This coordination process will provide both the focus and forum to expeditiously implement the program.

TUESDAY, MARCH 11, 1986.

NATIONAL SCIENCE FOUNDATION

WITNESSES

ERICH BLOCH, DIRECTOR
 MARY L. GOOD, MEMBER, NATIONAL SCIENCE BOARD
 JOHN H. MOORE, DEPUTY DIRECTOR
 RICHARD NICHOLSON, ASSISTANT DIRECTOR, MATHEMATICAL AND
 PHYSICAL SCIENCES
 NAM SUH, ASSISTANT DIRECTOR, ENGINEERING
 DAVID KINGSBURY, ASSISTANT DIRECTOR, BIOLOGICAL, BEHAVIORAL
 AND SOCIAL SCIENCES
 WILLIAM MERRELL, ASSISTANT DIRECTOR, ASTRONOMICAL, ATMOS-
 PHERIC, EARTH AND OCEAN SCIENCES
 RICHARD GREEN, ASSISTANT DIRECTOR, SCIENTIFIC, TECHNOLOGICAL,
 AND INTERNATIONAL AFFAIRS
 JOHN CONNOLLY, DIRECTOR, OFFICE OF ADVANCED SCIENTIFIC COM-
 PUTING
 PETER WILKNISS, DIRECTOR, DIVISION OF POLAR PROGRAMS
 BASSAM Z. SHAKHASHIRI, ASSISTANT DIRECTOR, SCIENCE AND ENGI-
 NEERING EDUCATION
 SANDRA TOYE, CONTROLLER
 JEFF FENSTERMACHER, ASSISTANT DIRECTOR, ADMINISTRATION
 RAMOND E. BYE, JR., DIRECTOR, OFFICE OF LEGISLATIVE AND PUBLIC
 AFFAIRS
 CHARLES HERZ, GENERAL COUNSEL

Mr. BOLAND. We are delighted to have with us today the National Science Foundation and its Director, Mr. Bloch. We will put all the names of those you have listed here as witnesses.

John Moore is the new Deputy Director. Richard Nicholson, where are you?

Mr. SUH. He is supposed to be sitting here.

Mr. BOLAND. How about William Merrell?

Mr. MERRELL. Here.

Mr. BOLAND. I know Sandra Toye has been here before. As a matter of fact, you ran one of our favorite programs and here you are now with one of our favorite agencies. You will think better about this when we mark the bill up.

Anyway, Ms. Toye had charge of the ocean drilling program, as I remember. This Committee, incidentally, was one of its strongest supporters. We are delighted to have all of you and want to welcome you all.

Just let me give you the box score. For fiscal year 1987, the Foundation has requested \$1,685,700,000. That compares to an appropriation of \$1,523,855,000 in 1986 or \$161,845,000 above the amount provided in our 1986 Act. However, Gramm-Rudman reduced that appropriation by \$65,525,763 to a new total of

\$1,458,329,235. So the 1987 request is \$227,370,776 above the amount provided after the application of Gramm-Rudman; is that correct?

Ms. TOYE. Yes.

Mr. BOLAND. However, in addition to the \$1,148,000,000 of new budget authority, there is a carry over of approximately \$31,750,000 for a total program level, as you have indicated, of \$1,490,000,000 in 1986. That is correct, isn't it?

Ms. TOYE. Yes, sir.

STATEMENT OF ERICH BLOCH, DIRECTOR, NSF

Mr. BOLAND. With that box score, we would like to hear your statement.

Mr. BLOCH. Thank you, Mr. Chairman.

I know you are tight for time, so I am going to keep my statement short. I assume my full statement will go into the record.

Mr. BOLAND. It will be in the record.

Mr. BLOCH. Let me comment on your introduction of the people here. For the first time in probably three years the Foundation has its full complement of executives in place and, as you know, that was one of my concerns last year. I am glad to say we have succeeded in that regard.

I think you will enjoy working with the team that we have assembled here.

Mr. BOLAND. We are delighted, Bill, working with them; aren't we?

Mr. GREEN. Certainly are.

Mr. BLOCH. Mr. Chairman, there are three reasons why the Federal Government supports research and education in the science and engineering areas. They are: its intrinsic intellectual value, because the Government needs the results, and for economic competitiveness.

The Foundation has long been dedicated to the first reason—intrinsic intellectual value. And the Congress has long supported this quest to do the best possible science in every field. We will continue to support excellence in pursuit of this goal, as we always have.

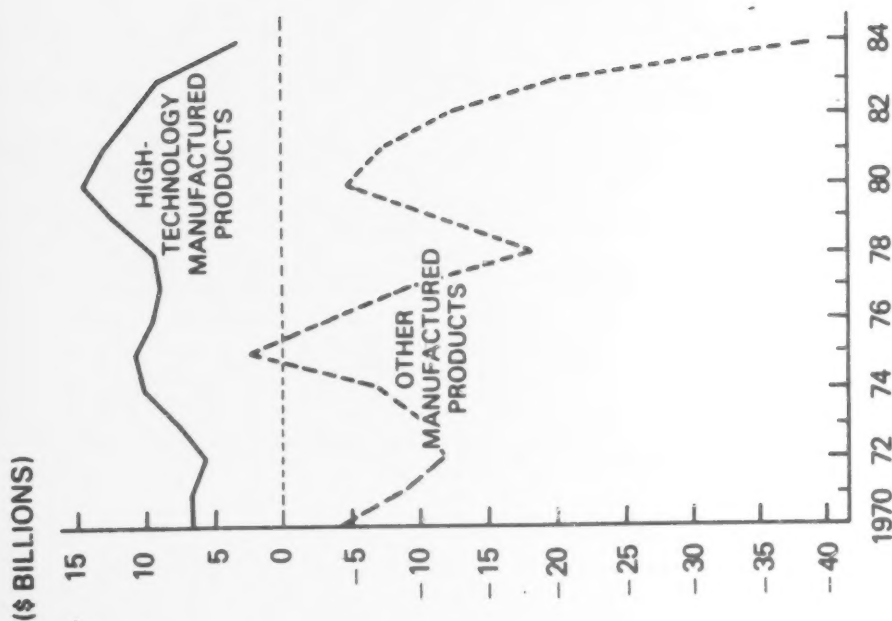
The second goal is to create the new knowledge that Government itself needs in support of specific missions such as defense, health or agriculture. This is principally the concern of the mission agencies, but also ours, which we will be discussing in the next day.

I will concentrate my remarks this morning on the third goal, that of economic competitiveness. This is the area in which the Nation is most in need. It is an area in which the National Science Foundation has much to offer, and it is the rationale behind our major budget thrusts this year.

It is no secret that the world has become a much more competitive place in recent years. Consider these facts—I want to direct your attention to chart number 1.

[The chart follows:]

U.S. TRADE BALANCE IN HIGH-TECHNOLOGY AND OTHER MANUFACTURED PRODUCT GROUPS, IN CONSTANT DOLLARS



Mr. BLOCH. Our trade balance is overwhelmingly negative, and becoming more so. Even the advantage in high technology products that we once took for granted is eroding, as you can see from the top of this particular chart. As a matter of fact, we are getting to a zero balance pretty soon. Semi-conductors is one particular example that you can read about every day in the newspapers.

In both high and low technology products, the markets in which we must compete are increasingly international. The company that is first in the market with the most technically advanced product at the best price is the one that will succeed.

IMPORTANCE OF RESEARCH

Let me talk about research and why it is important. Research provides the underlying base for the new products that we need to compete in high technology areas. And new process improvements can raise productivity in low technology manufacturing and service industries.

In quantitative terms, as you can see on chart No. 2, technological innovation created through research has been responsible for nearly half of all productivity gains since World War II. Research has been far more important than economies of scale, for example.

[The chart follows:]

CONTRIBUTORS TO U.S. PRODUCTIVITY INCREASES



Mr. BLOCH. Many of NSF's programs support this process of innovation: robotics, engineering research centers, biotechnology, materials research, education of future scientists and engineers and many more.

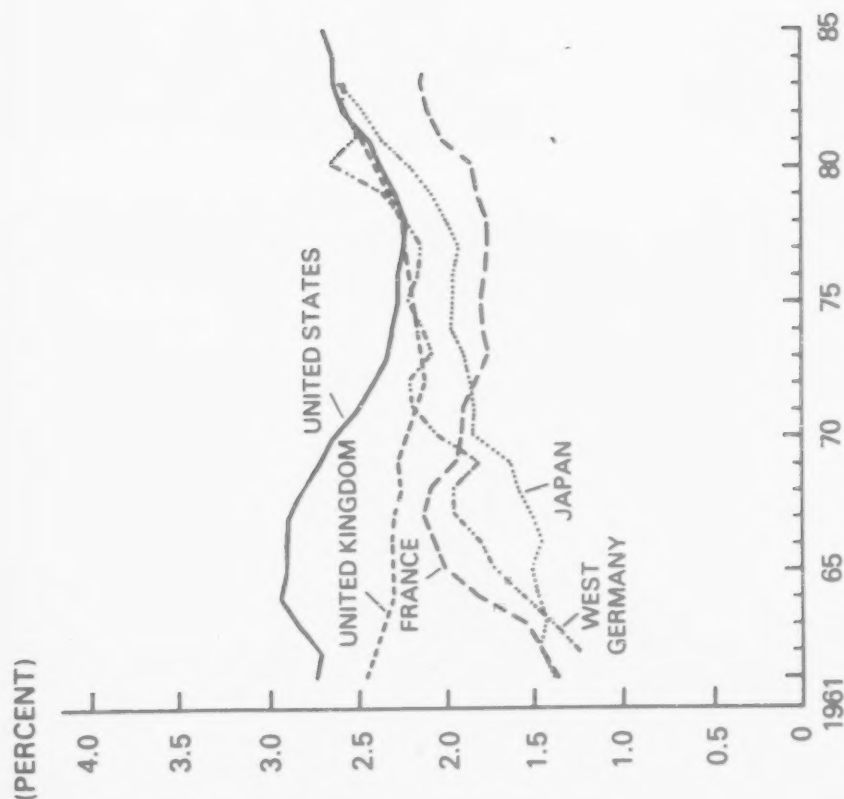
Research is the right way to enhance our international competitiveness, and is far preferable to reliance on trade barriers or other protectionist measures.

As our society becomes more and more dependent on technology, we must be sure that we do three things: support basic research adequately; educate enough new scientists and engineers; and invest sufficiently in research facilities and equipment.

As chart No. 3 shows, the United States has not invested in R&D in recent decades at the rate that sustained growth in a modern technological society requires. We have slipped from the position of leadership we held 20 years ago, while our competitors have been pushing ahead in an effort to challenge and surpass us in key technological areas, at least as measured by their gross national product.

[The chart follows:]

NATIONAL EXPENDITURES FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT AS PERCENT OF GROSS NATIONAL PRODUCT BY COUNTRY



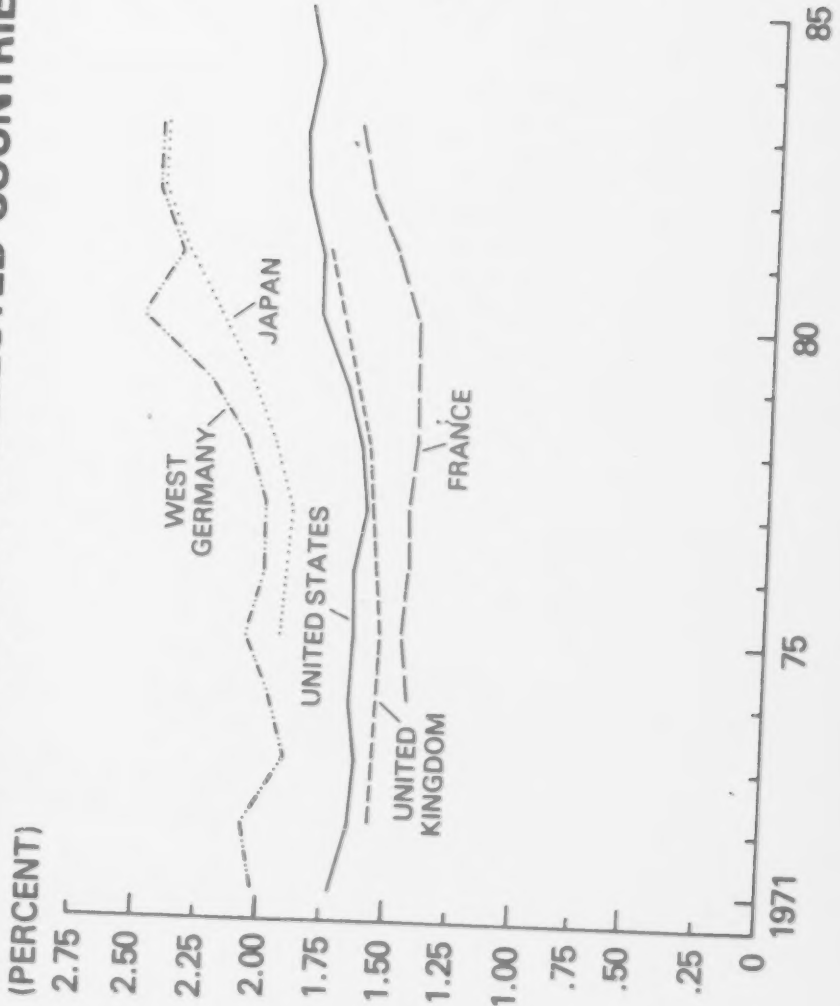
Mr. BOLAND. They had further to come.

Mr. BLOCH. Yes. They did have further to come.

I want to go the next chart, chart No. 4, showing you the same ratio but this time for non-defense R&D only. What you see here is essentially the United States is in the middle of the pack, not on the top. I think this is a much better measure of where we are in respect to our trading partners and our competitors from overseas.

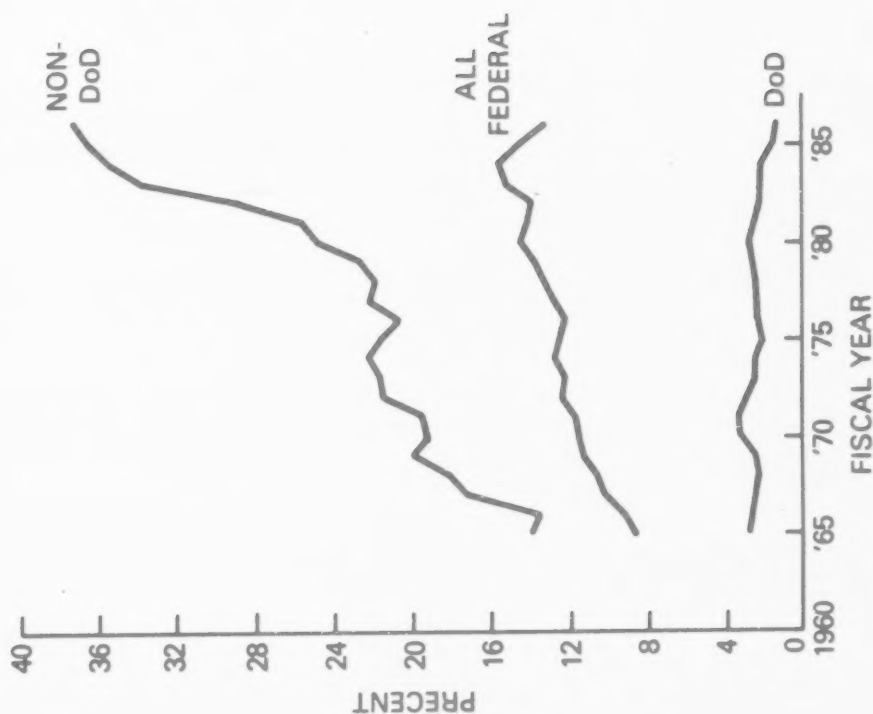
[The chart follows:]

ESTIMATED RATIOS OF NON-DEFENSE R&D EXPENDITURES TO GROSS NATIONAL PRODUCT (GNP) FOR SELECTED COUNTRIES



Mr. BLOCH. An encouraging trend, (chart No. 5) however, is that our Federal expenditures for domestic R&D are increasingly for basic research. You see the total basic research is increasing and has been over the last three or four years, but when you look at the middle of the chart where it shows basic research as a proportion of all Federal R&D, you see that basic research is dropping. [The information follows:]

BASIC RESEARCH AS A PROPORTION OF ALL R&D



Mr. BLOCH. We have been dropping over the last two years. Now, one can ask the question, is that an optimum level of support for basic research? There is no simply answer to that question, but when it is true that basic research is dropping as a proportion of total Federal support, and we see increasing competition from our trading partners, and we see shortages of scientists and engineers developing, and we all agree that facilities and instrumentation in universities are in a deplorable condition, then we can only conclude that we are under-funding basic research, especially in the universities.

NEED TO SUSTAIN POPULATION OF SCIENTISTS/ENGINEERS

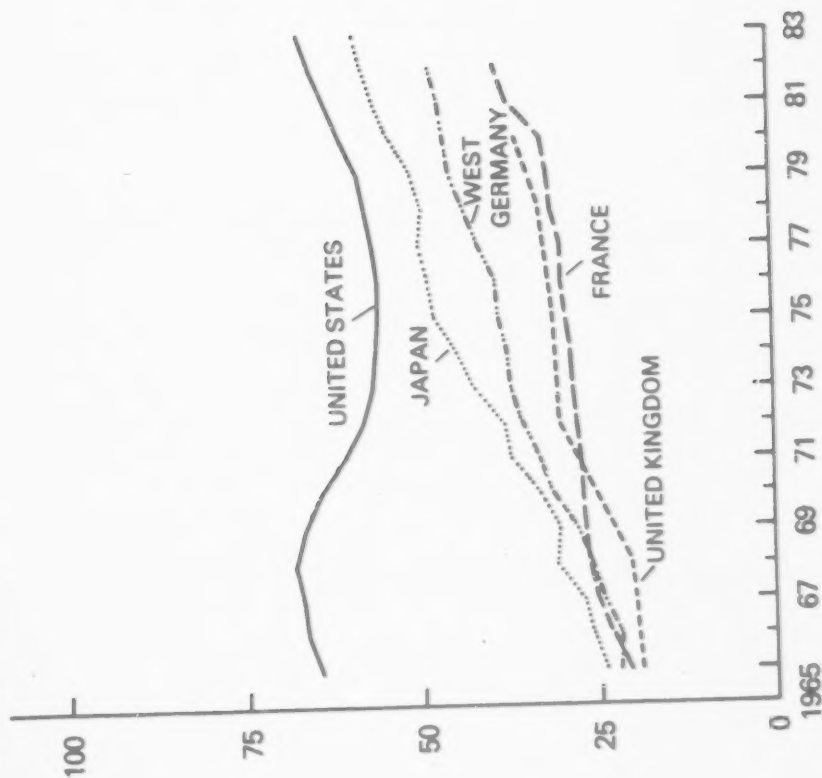
As our society becomes more dependent on technology we will need more of our population educated in science and engineering. A consequence of under-funding basic research, however, is that we are attracting too few young people to these areas.

Twenty years ago the United States had far more scientists and engineers per capita of the labor force than any of our competitors. Today that is no longer the case. As you can see from chart No. 6, Japan and West Germany are catching up with us very fast.

[The chart follows:]

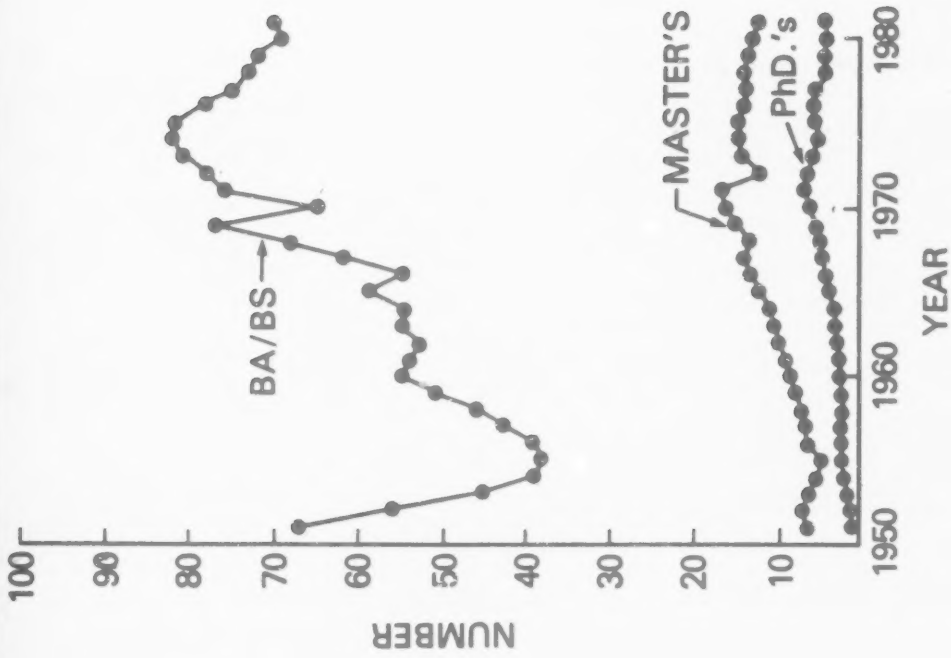
SCIENTISTS AND ENGINEERS ENGAGED IN RESEARCH AND DEVELOPMENT PER 10,000 LABOR FORCE POPULATION BY COUNTRY

(Per 10,000 labor force)



Mr. BLOCH. If you look at the next chart, No. 7, the proportion of our young people who are being attracted to scientific and engineering programs is declining.

[The chart follows:]



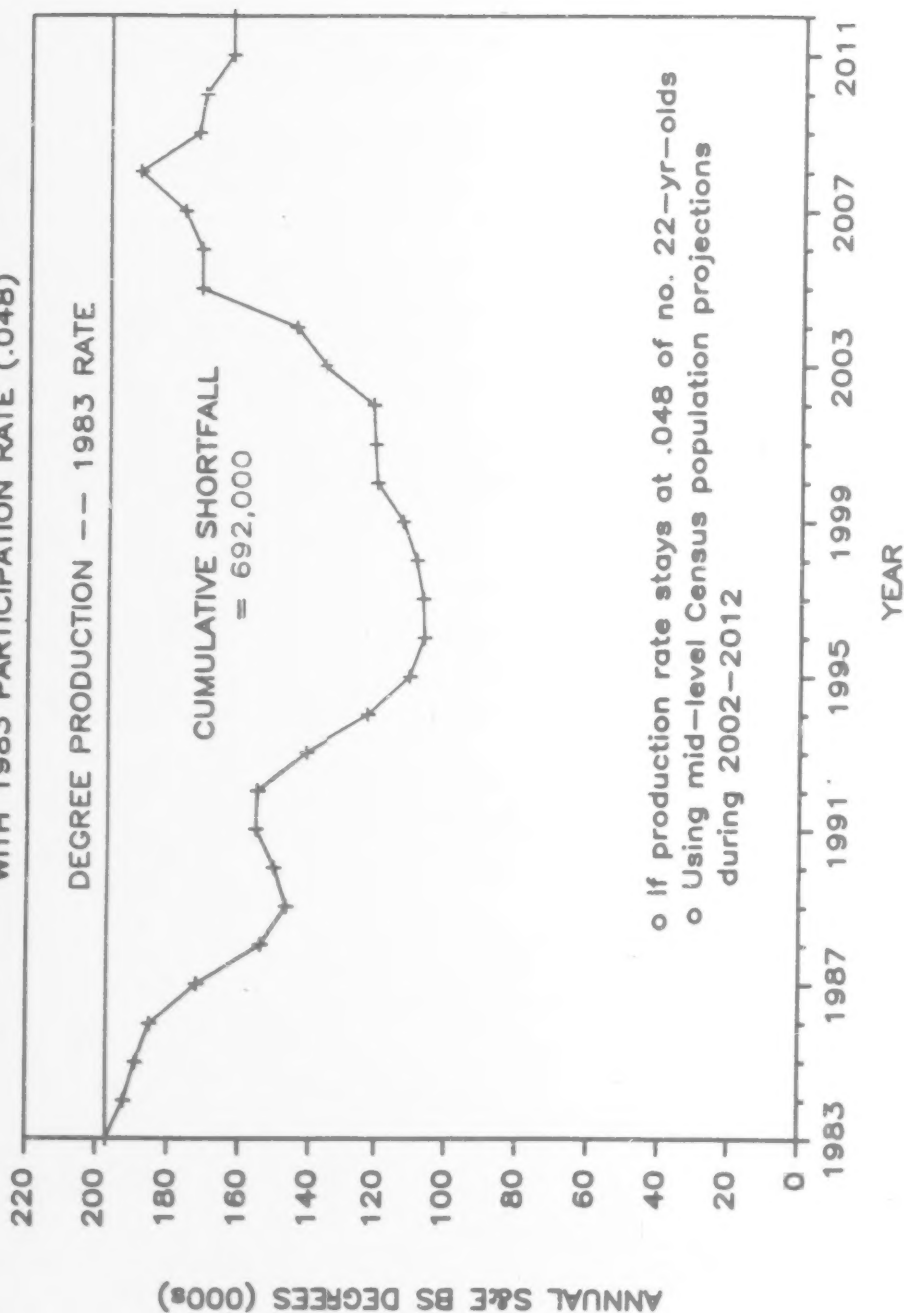
SCIENCE/ENGINEERING
DEGREES PER
THOUSAND IN
APPROPRIATE AGE
COHORT, 1950-1981

Mr. BLOCH. Even if we could continue to attract students at the 1983 rate, the decline in numbers of 22 year olds means that we would produce nearly 700,000 fewer graduates in these fields in the next 20 years, because of this decline of the appropriate age group population, as chart No. 8 shows.

[The chart follows:]

S&E BS PRODUCTION RATES

WITH 1983 PARTICIPATION RATE (.048)

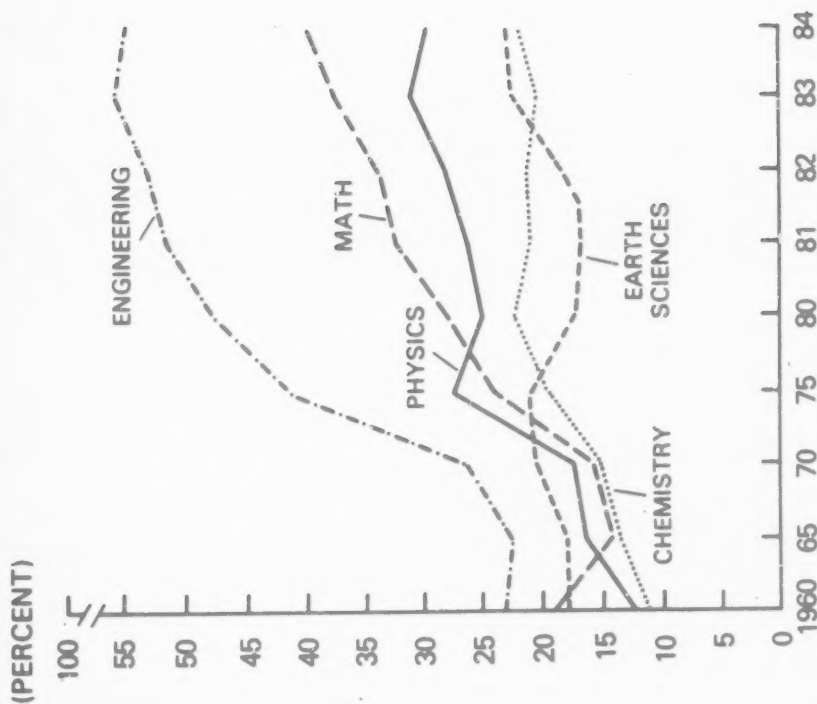


Mr. BLOCH. Chart No. 9 shows that, increasingly, we are dependent on foreign nationals for new Ph.D.s in engineering, math, and physics, the most critical disciplines of a technological society. While we benefit from this, while many students stay here to join the U.S. work force, we have an over-dependence on the resource that is not under our control and that can vanish on us quickly.

[The chart follows:]

DOCTORAL DEGREES AWARDED TO FOREIGN STUDENTS AS A PERCENT OF ALL DOCTORAL DEGREES FROM U.S. UNIVERSITIES, BY FIELD

ENGINEERING, MATHEMATICS,
AND PHYSICAL SCIENCES



Mr. BLOCH. The NSF budget request is an 8.4 percent increase. This year, again, the President has singled out support of science/engineering as a high priority area. This signals administration emphasis on basic research in science and engineering. Basic research in science and engineering in the U.S. is synonymous with education. The two are intertwined because most of our Federal supported basic research—60 percent—is in universities and the Foundation's budget supports education and research.

Putting the NSF budget in perspective, if you turn to the next chart (No. 10), you see that basic research is 16 percent of the \$61 billion of the Federal R&D budget. The NSF share is 16 percent of the basic research budget or three percent of the total.

[The chart follows:]

FEDERAL SUPPORT FOR R&D, FY 1987
- BY CHARACTER OF WORK -



Mr. BLOCH. The next chart (No. 11) shows that of basic research, over 50 percent is in academic institutions and the NSF share of that is about 25 percent. I want to point out what I am showing on that particular chart is total university R&D, which is about \$6.8 billion.

[The chart follows:]

FEDERAL SUPPORT FOR BASIC RESEARCH, FY 1987
- BY MAJOR PERFORMER -



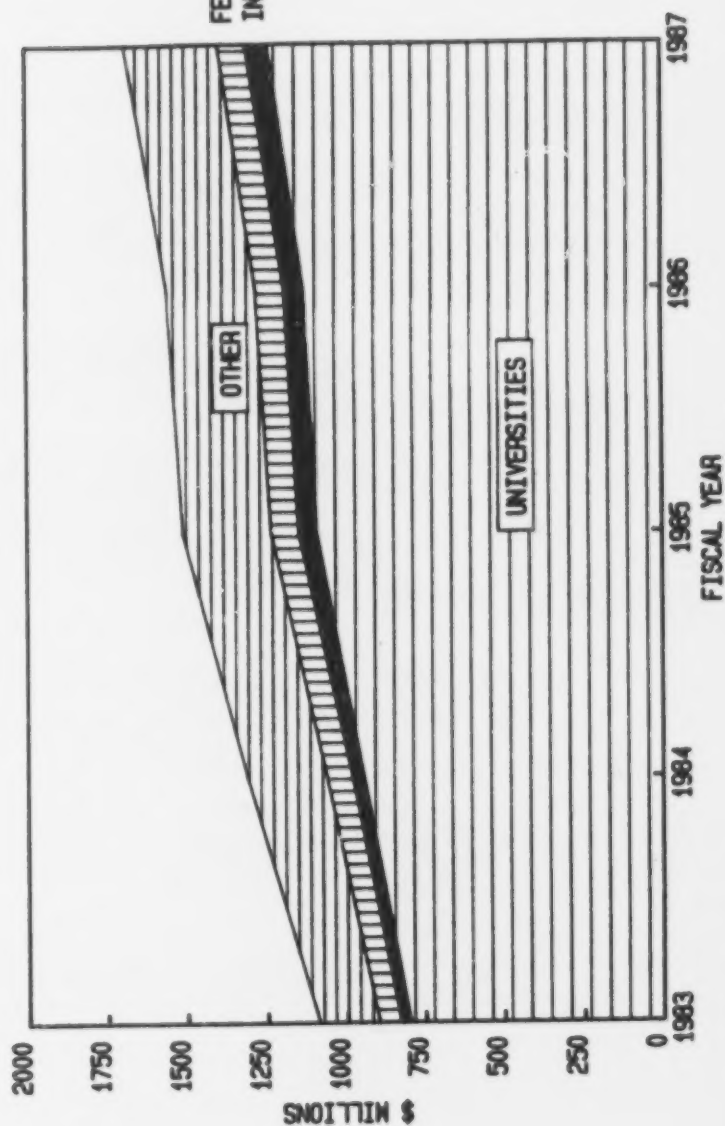
Mr. BLOCH. University research is \$4.5 billion. While NSF is small in total R&D terms, it is significant in university research. That is why we are focusing on that particular parameter very extensively.

Our budget is spent predominantly in universities as you can see on the next chart (No. 12).

[The chart follows:]

NATIONAL SCIENCE FOUNDATION DOLLAR DISTRIBUTION BY PERFORMER

1983 - 1987



DEVELOPING SCIENCE/ENGINEERING PERSONNEL

Mr. BLOCH. The other area, which is the second largest area, are institutions that are managed by universities such as NCAR, Antarctica, telescopes and ships.

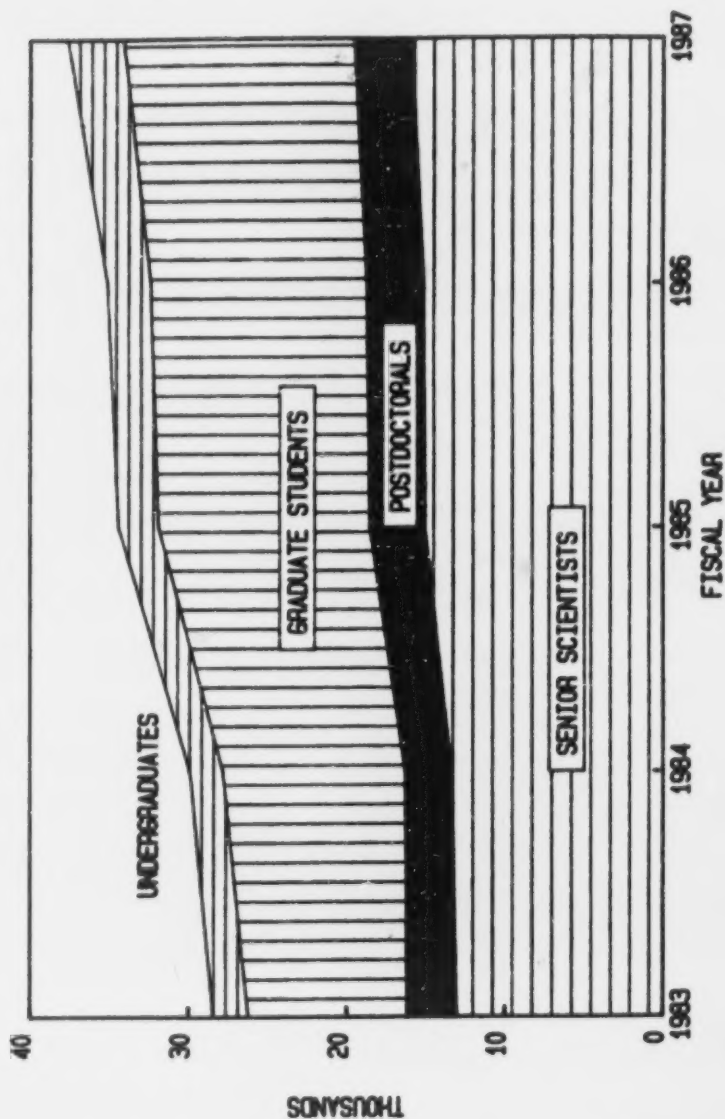
The Foundation is trying to address a number of problems with the budget: the first is developing science/engineering personnel.

If you look on the next chart (No. 13), you will see what support we are providing. Besides principal investigators support of about 13,000 people, we are providing 3700 post-doctorates and about 14,000 graduate students, including 1500 graduate fellows.

[The chart follows:]

NATIONAL SCIENCE FOUNDATION RESEARCH GRANT PERSONNEL

1983 - 1987



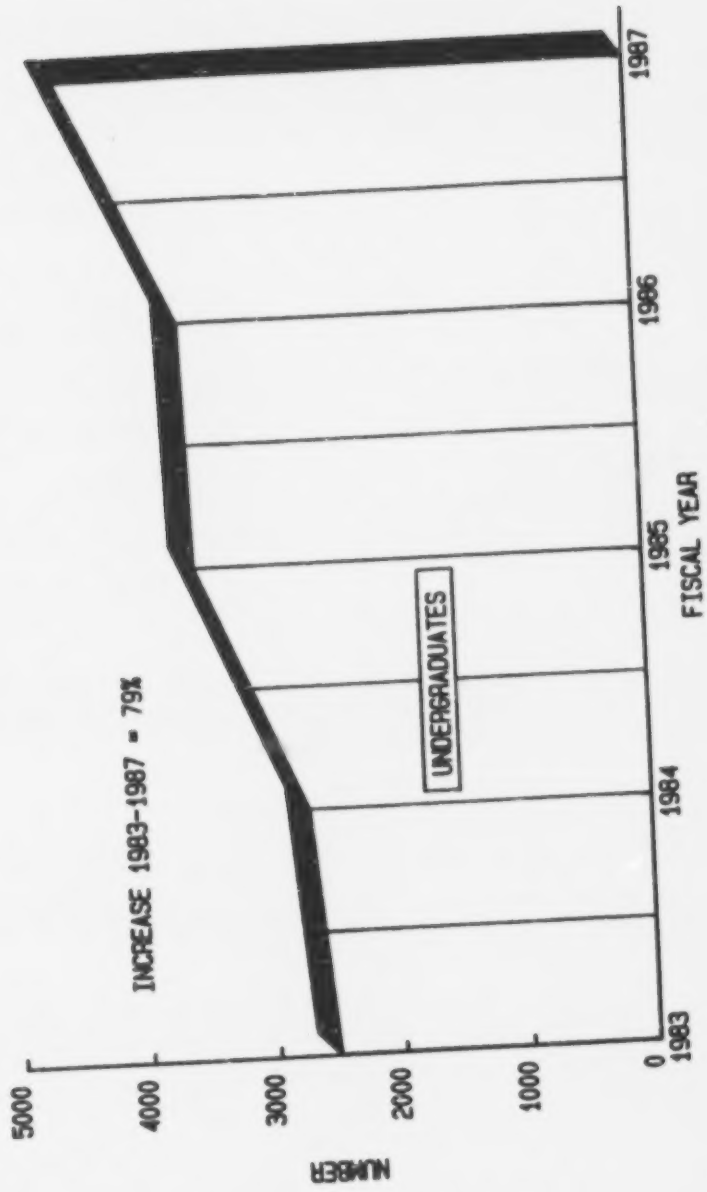
Mr. BLOCH. In addition, we are reaching 10,000 teachers through our pre-college education program for short periods of time in special activities and special courses.

The second point, partly addressed in chart No. 14, which we want to address in the budget is the broadening participation. The Foundation has a dual role to play. It is to stay ahead in research, and make sure that the country stays ahead in research, and assure its excellence, and the second goal is to ensure the broadest possible participation.

[The chart follows:]

NATIONAL SCIENCE FOUNDATION UNDERGRADUATE SUPPORT

FY 1983 - FY 1987



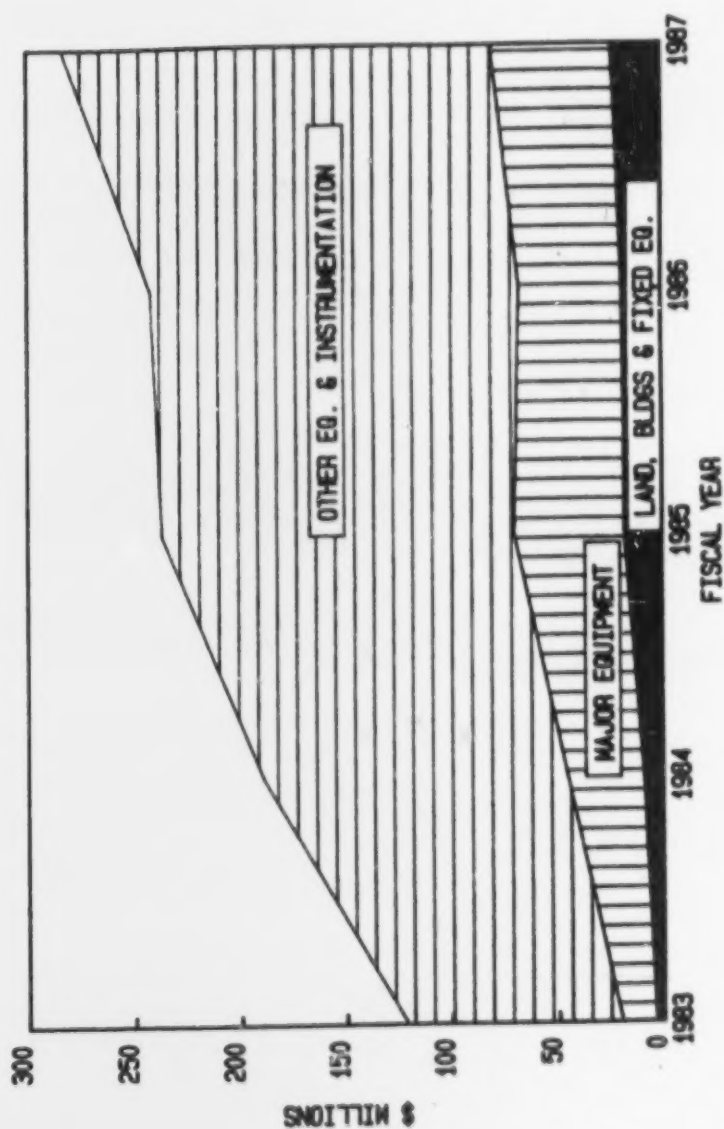
Mr. BLOCH. There are some legitimate considerations. Participation by the varied institutions that make up science and engineering and the research base of our country is one of the concerns, and to give access to all groups of our very heterogenous society.

Minorities and women is the second area of concern. A third area the budget addresses is the infrastructure. If you look at chart No. 15 labelled equipment categories, you can see what we mean by that.

[The chart follows:]

NATIONAL SCIENCE FOUNDATION EQUIPMENT CATEGORIES

1983 - 1987



Mr. BLOCH. Research depends increasingly on highly sophisticated equipment and facilities. We have to reduce or reschedule several major capital investments as a response to financial constraint of 1986. This is not acceptable in the long term.

The leveling off, shown in the chart for major equipment, is something we cannot continue forever. The state of the art instrumentation is the biggest area in red. Equipment and instrumentation is the one area we have been focusing on because it is lagging behind in support and has been lagging over the last few years.

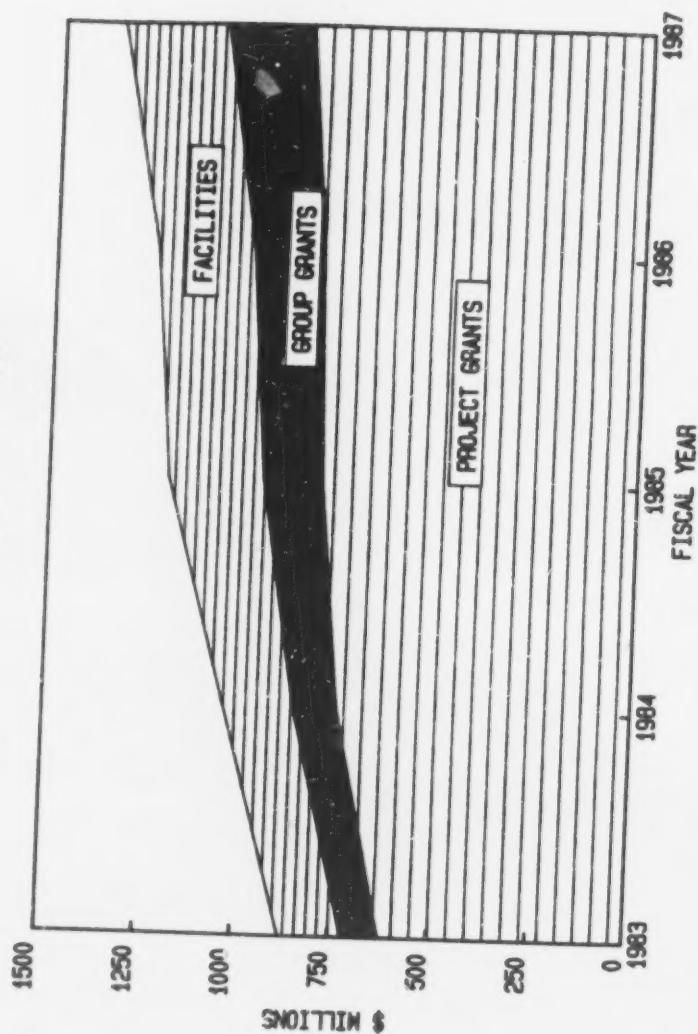
We are supporting many disciplines from mathematics to behavioral sciences, from physics and chemistry to engineering disciplines. Some of the work is best suited for individual grants by individual investigators; some concentrated in groups, others in large facilities.

The last chart (No. 16) shows what we mean. The balance between the three forms of organization is important. We are constantly reassessing this balance.

[The chart follows:]

NATIONAL SCIENCE FOUNDATION PROJECT BALANCE

FY 1983 - FY 1987



* INCLUDES MPS, AAEO, BBS, ENG, & ASC ONLY

Mr. BLOCH. I am sure we will get into details tomorrow also reflected in the budget book.

You suggested last year we reduce the size of the budget book and we have done so, and I hope it is easier to read and to comprehend in this new form.

Mr. Chairman, the strongest case that I can make for the support of the President's budget request for the National Science Foundation is that we must begin to do something about the trends that I have just outlined, alarming kinds of trends.

It is encouraging that even in a time of great austerity in Federal funding, the Administration has recognized the need for an increase in our budget. The proposed increase will go where it will do the most good: to support basic research and education in the fields most critical to our economic competitiveness.

Mr. Chairman, I would like to leave you with one overriding thought. Investment in science and engineering research and education has been the source of much of our economic progress in the last four decades. It continues to be the best single way that we can provide the jobs and national welfare that we must have in decades to come.

I urge you to ensure that we have the resources necessary to make this investment in our future.

Thank you.

[The statement of Mr. Bloch follows:]

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

It is a pleasure to meet with you today to discuss the FY 1987 Budget Request for the National Science Foundation.

Mr. Chairman, I want to focus on the context for the 1987 NSF budget: the importance of basic research to the nation, the strategy underlying the 1987 request, and some highlights.

BASIC RESEARCH IN THE UNITED STATES

The Federal government will provide about \$61 billion for support of R&D activities in FY 1987. Basic research accounts for only \$8.6 billion, or 14%, of this total. Federal support of basic research is estimated to increase by 8% in FY 1987. Since a higher percentage increase is projected for support of development activities, the share of research dollars that is devoted to basic research is dropping.

Contrary to other countries, in the U.S. about half of all basic research activity takes place in colleges and universities. We have chosen to locate so much of the federal support for basic research at our academic institutions because in this way we can ensure the continued production of top quality scientists and engineers for academia, industry, and government. As a consequence, higher education and research are inexorably intertwined; supporting one is supporting the other. This is one of the great strengths of our system and we must continue to nurture it.

The President's Budget Request for NSF shows an increase of 15.6% above the New Obligational Authority provided for FY 1986 as altered by the Gramm-Rudman-Hollings process. This signals the emphasis this Administration places on basic science and engineering as a force for present and future competitiveness, as a prerequisite for the products and services that improve the lives of our citizens, and as a base for building a strong national defense.

This increase occurs even in the face of large federal deficits and efforts to reduce federal spending because investment in basic science and engineering is essential to improving our competitiveness internationally and reducing our trade deficit.

NSF has a unique role in the federal support of science and engineering research and education. Our programs provide support for promising ideas across all fields of science and engineering and complement the support provided by the more mission-oriented federal agencies.

NSF accounts for less than 3% of the federal support for total research and development. However, it provides nearly 17% of federal basic research dollars and about 25% of the federal support for basic research at colleges and universities. This support allows researchers to tackle problems that require longer-term investments not directly driven by the need for specific applications. It is from support such as this that genuine breakthroughs occur, innovation is stimulated and Nobel prizes are earned.

PROBLEMS AND BUDGET STRATEGY

The problems that we must address are the following:

1) Our support of basic research and education in science and engineering needs strengthening when one considers the increasing rate at which advances and new developments are taking place and the increasing emphasis and significant progress that other nations are making in this area.

2) We are not attracting enough young people to science and engineering to assure an adequate supply in the future.

3) Our investment in the infrastructure of science and engineering--equipment, instrumentation, and facilities--must continue.

The Foundation's budget strategy for FY 1987 addresses these issues. This strategy

- o provides for continuity by maintaining balanced support for research of proven quality across all disciplines,
- o ensures change by investing significant resources in a selected number of areas that offer particular promise for scientific and engineering advances, and
- o stresses fiscal responsibility by leveraging Federal resources wherever possible and by phasing down or terminating activities of lower priority or lesser promise.

STIMULATING COMPETITIVENESS AND INNOVATION

Recognizing the importance of stimulating economic competitiveness is a critical at this time in our nation's history. We have gone

from being a creditor nation to one with growing trade deficits. Trade protection, however, is not the answer; developing and being first in the use of new technologies is the answer. Therefore, support for basic research and education in science and engineering is essential. Even in the short term, investments in basic research will help to improve our competitiveness. In the longer run, failure to provide substantial support for basic research and education is sure to have grave consequences.

Through support for such programs as the Engineering Research Centers, initiated in FY 1985, we are providing opportunities for industrial and academic engineers and scientists to work together in areas of inquiry which require a stronger fundamental research base for future advances. These centers also provide experiences for undergraduate and graduate students which can better prepare them for careers in industrial research. Six centers have been established. We will very shortly announce awards for four or five more, and the FY 1987 budget request includes support for an additional four centers.

There is great potential for long-term economic payoff in other research areas, including materials, chemistry, computer science and biotechnology. All of these areas receive enhanced support in FY 1987, both in ongoing base programs and through the special emphasis areas of computational science and engineering, biotechnology, and global geosciences.

Our efforts in support of research conducted by small businesses and of joint industry-university research ventures are directly aimed at encouraging innovation and building stronger links between basic research activities of today and economic advances in the future.

DEVELOPING SCIENCE AND ENGINEERING PERSONNEL

The human resource pool that will provide the scientists and engineers of the future is critically important. For the young men and women already in the career pipeline, NSF provides support for the initiation of individual research programs at colleges and universities, for postdoctoral opportunities, and for graduate research assistantships and fellowships. At the undergraduate level, and particularly the precollege years, where career decisions are not yet firm, the Foundation directs special efforts toward making scientific and technical careers attractive and attainable. In all of these efforts, increasing the participation of women, minorities, and physically disabled persons in the scientific and engineering activities is an important Foundation goal.

Support for precollege science and mathematics activities is stabilized at the FY 1986 level. The FY 1987 program builds on,

and continues, activities begun earlier. These include materials development, informal education, teacher preparation and enhancement, and studies and assessments. These activities are all consistent with the functional objectives as described in the reauthorization of the Education for Economic Security Act, P.L. 99-159. All of the science and mathematics fields taught at the K-12 levels are covered. In the teacher enhancement area, about 10,000 teachers per year are participating in projects. The goal of these activities is to improve the quality of precollege instruction in science and mathematics, provide meaningful out-of-school experiences for young people, and stimulate young men and women to consider careers in science and engineering fields.

The science and engineering education management study mandated in the FY 1985 Appropriation for NSF has been funded. The study will be completed in 18 months, with several interim reports required. As information becomes available it will be used in updating and reformulating the Science and Engineering Education long range plan.

IMPROVING THE PHYSICAL INFRASTRUCTURE OF SCIENCE AND ENGINEERING

Advances in science and engineering are increasingly dependent on the equipment available to researchers. Instrumentation and facilities must be of the highest quality possible if we are to maintain our science and technology base and realize future advances.

In recent years, we have reduced or rescheduled several major capital investments in research facilities. This has been a necessary and appropriate response to financial constraints. However, it does not constitute an acceptable long-term policy for research support. This budget includes support for on-going capital improvements; no new starts are included.

Each facility improvement has been carefully examined to ensure that the support we are requesting balances the need for fiscal restraint and the scientific need for the facility. For example, the Cornell Electron Storage Ring upgrade will continue (although its completion will be delayed one year), while construction of the Michigan State University Cyclotron and the Indiana University Cooler Ring will be completed. Support for the construction of the Very Long Baseline Array will be maintained at essentially the FY 1986 level.

Modern research requires state-of-the-art instrumentation and equipment. Accordingly, the FY 1987 budget request includes funds

for increased investment in discipline-specific research instrumentation programs and for an expansion of the College Science Instrumentation Program. Total support for instrumentation and equipment increases from \$223 million in FY 1986 to \$260 million in FY 1987. Increases for instrumentation occur throughout the disciplines supported by the Foundation, with special attention focused on the biological sciences this year.

LEVERAGING FEDERAL DOLLARS

NSF continues in FY 1987, as in previous years, to leverage Federal dollars by encouraging and requiring the participation of private sector organizations, academic institutions, and state and local governments as partners in funding research and education. Some programs require contributions from these and other sources.

Examples of the successes we have achieved in attracting outside funding to complement and extend the support by NSF:

- o The six Engineering Research Centers established last year have generated approximately \$13 million in industrial support;
- o The National Advanced Scientific Computing Centers which were also initiated last year have raised a 40 cent match for every dollar the Federal Government spends;
- o The \$5.5 million provided for the FY 1985 College Science Instrumentation program awards will be matched by at least an equal amount; and
- o The FY 1984 class of Presidential Young Investigators has succeeded in obtaining nearly \$11 million in matching funds.
- o So far during FY 1986, \$1.9 million NSF investment in precollege instructional development has been matched by nearly \$9 million from other sources.

THE NSF BUDGET REQUEST FOR FY 1987

The strategy we have adopted is embodied in the Foundation's FY 1987 Budget Request, which totals \$1,685.7 million or 13.19% above the approved FY 1986 Post Gramm-Rudman-Hollings (G-R-H) Current Plan of \$1,489.8 million. This Current Plan is composed of \$1458.3 million in New Obligational Authority (NOA) and \$31.5 million deferred from FY 1985 for use in FY 1986 for Science and Engineering Education. The FY 1987 Request is therefore 15.6% above the FY 1986 NOA. It includes:

- o \$1,479 million for Research and Related Activities, an increase of 14.3%
- o \$117 million for the U.S. Antarctic Program (USAP), up 6.4%. (A budget base transfer of \$14.4 million was made to the U.S. Coast Guard to cover basic icebreaker services. Those funds include part of a \$3.0 million increase in Coast Guard charges.)
- o \$89 million, or a 5.1% increase, for Science and Engineering Education. (The carryover of \$31.5 million from FY 1985 into FY 1986 has been made part of the base for Science and Engineering Education.)
- o \$0.7 million in Special Foreign Currency funds.

This Budget Request, if approved by Congress:

- o Will maintain balanced support for research of proven quality across all disciplines.
- o Will allow significant increases for a small number of multidisciplinary special emphasis areas where additional funding can have a multiplier effect by establishing new institutional arrangements and capabilities for encouraging the collaboration that accelerate scientific productivity.
- o Will provide support for facilities which are an integral part of research activities in fields such as physics, materials, advanced scientific computing, astronomy, and the geosciences.
- o Will stabilize funding for the Science and Engineering Education activity, maintaining the FY 1986 level for graduate and precollege programs and an increase for the College Science Instrumentation Program.

Highlights of the specific research activities and programs of the Foundation follow.

MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

The FY 1987 Budget Request for MPS is \$449.3 million, an increase of \$56.6 million, or 14.4 percent, over the FY 1986 Post G-R-H Current Plan. Increases are requested for all of the subactivities: 12% for Physics and Materials Research, 16% for Computer Research, 18% for Chemistry and 16% for Mathematics.

Emphasis on Mathematical Sciences continues the Foundation's

priority to rebuild the personnel base in U.S. mathematics, a discipline which underlies much of the work that is undertaken across the science and engineering disciplines.

Also included in the MPS Request are: enhanced support for research on advanced computers, increased support for chemical instrumentation, expansion of the Materials Research Groups, and funds for design of a prototype for a gravity wave detector.

MPS disciplines will play a major part in the Foundation-wide emphasis in FY 1987 on computational science and engineering. Through this emphasis research on new or improved methods of solving scientific problems using advanced computers and algorithms will be supported. Mathematicians, computer scientists, and scientists and engineers from other disciplines will form collaborative teams to attack complex problems in an integrated, complementary way.

ENGINEERING (ENG)

Much of the focus of the research programs of the Engineering Activity is on high-leverage, fundamental and cross-disciplinary research aimed at expanding the engineering knowledge base, stimulating innovation, and contributing, in the long term, to national economic competitiveness.

The FY 1987 Request for Engineering is \$185.5 million, an increase of \$30.9 million, or 20.0 percent over the FY 1986 Post G-R-H Current Plan of \$154.6 million. The Engineering Research Centers program is increased to a total of \$35 million. Up to four new centers will be initiated in FY 1987, bringing the total to 15.

Increases for ENG will enhance its participation in the Foundation's special emphases in biotechnology and computational science and engineering. Other areas chosen for enhancement include design, manufacturing and systems integration and materials processing, areas where international competition is keenest.

BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES (BBS)

The FY 1987 Budget Request for BBS of \$282.4 million is an increase of \$34.9 million or 14.1 percent over the FY 1986 Post G-R-H Current Plan. Increases for BBS subactivities range from 12 to 14 percent, except for Information Science and Technology which shows a 35 percent increase.

This large increase in Information Science and Technology results from research emphasis on advanced computers, such as distributed

systems and parallel processing machines. Additional emphasis is being placed on problems of scaling up from theoretical to implemented systems. Improved instrumentation support is a key component of this increase.

The main focus in BBS continues to be progress toward increasing knowledge about life and social processes. Primary emphasis is placed on research related to biotechnology. Two to four biotechnology research centers will be established and departmental awards for multi-user equipment will be provided. In addition, crossdisciplinary training for advanced students will be emphasized.

Throughout the BBS Activity, increased funds have been included for the instrumentation necessary to keep pace with fast-moving research developments. In addition, through its Biotic Systems and Resources subactivity, BBS will collaborate with the Astronomical, Atmospheric, Earth and Ocean Sciences Activity in research efforts in global geosciences.

Finally, the important NSF role of stimulating the refinement of data collection and handling techniques in the behavioral and social sciences will be maintained.

ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES (AAEO)

The FY 1987 Budget Request for AAEO of \$383.2 million is an increase of \$36.8 million, or 10.6 percent over the FY 1986 Post G-R-H Current plan of \$346.4 million. This increase is not evenly distributed among the five subactivities within AAEO, and ranges from six percent in Astronomical Sciences to 18 percent in Earth Sciences. The majority of the increase is devoted to two new emphases--global geosciences and computational science and engineering--as well as to a continuing emphasis on studies of the continental lithosphere.

Increases in Atmospheric and Ocean Sciences are planned for global studies of ocean circulation; the physical climate system, including the interaction between the atmosphere and oceans; the chemistry of the troposphere, cycling of biological and chemical species through the atmosphere, oceans, and seafloor; and the interrelated processes occurring at ocean ridge crests. The remainder of the Budget Request will be used to maintain support for high quality research projects and operation of major facilities, including the national astronomy centers, the National Center for Atmospheric Research (NCAR), and the Ocean Drilling Program.

SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS (STIA)

STIA carries out activities that cut across all the scientific and engineering disciplines supported by the Foundation. In addition, STIA serves as a management focal point for many of the cross-disciplinary programs which are funded by the research directorates.

The FY 1987 Budget Request of \$47.0 million is an increase of \$9.1 million, or 24.0 percent over the FY 1986 Post G-R-H Current Plan of \$37.9 million. The largest part of the increase, \$4 million, is to initiate a new program of Minority Research Centers of Excellence. These centers are designed to increase more rapidly the participation of minorities in science and engineering by upgrading research and teaching capabilities of selected minority institutions.

Other increases in the STIA Budget Request include \$2.3 million for the Small Business Innovation Research (SBIR) program, for a total of \$17.15 million, and \$2.4 million for international programs, for a total of \$12.7 million. In addition, the study of university facilities and instrumentation mandated by the Congress will be continued through the Science Resources Studies subactivity. Policy Research and Analysis support remains at the FY 1986 level.

ADVANCED SCIENTIFIC COMPUTING

The FY 1987 Budget Request for Advanced Scientific Computing is \$53.6 million, \$10.6 million or 24.7 percent over the FY 1986 Post G-R-H Current Plan of \$43.0 million. This increase will allow the continuation and further development of advanced computing resources for science and engineering research.

The national centers established in FY 1985 and FY 1986 will be enhanced and their services expanded to more scientists and engineers. No new centers will be initiated in FY 1987. The interim resource center effort will continue to be phased down in FY 1987 as the national centers build up to full operational capacity.

The development of a national network linking scientists and engineers with the national computing centers and each other will continue in FY 1987. Support for the experimental computing center at Cornell University will be maintained, as will support for the use of other experimental hardware and software development.

U.S. ANTARCTIC PROGRAM (USAP)

The FY 1987 Budget Request for the U.S. Antarctic Program is \$117.0 million, an increase of \$6.8 million or 6.2 percent over the FY 1986 Post G-R-H Current Plan of \$115.2 million. A budget base transfer of \$14.4 million to the U.S. Coast Guard for the fixed costs of icebreaker support will take place in FY 1987. NSF will continue to budget for the incremental cost of icebreaker operations in antarctic waters.

Research topics to be emphasized in FY 1987 include atmospheric chemistry, marine ecosystems, ice dynamics, and geologic structure and tectonics of the Transantarctic Mountains and West Antarctica.

The Budget Request for Operations Support of \$105.0 million includes funds for upgrading of the LC-130 aircraft and a start on construction of a science laboratory at McMurdo Station to replace the present makeshift facilities.

SCIENCE AND ENGINEERING EDUCATION

The Budget Request for Science and Engineering Education for FY 1987 is \$89.0 million, a \$4.3 million increase over the FY 1986 Post G-R-H program level and \$35.8 million above the New Obligational Authority provided in FY 1986. This results from the fact that \$31.5 million was deferred from FY 1985 for use in FY 1986.

The FY 1987 plan is characterized by stability, particularly for the precollege level programs. They are much the same in both character and funding level in FY 1986 and in FY 1987. Support is provided for materials development, informal education, teacher preparation and enhancement, and special studies and assessments.

The Graduate Fellowships program increases \$1.2 million over the FY 1986 Post G-R-H level of \$26.1 million. This will provide support for about 560 new fellows and 970 continuing fellows. The stipend level remains at \$11,100 and the cost-of-education allowance at \$6,000.

An increase of \$2.3 million is sought for the College Science Instrumentation Program. This brings the level of the program to \$7.5 million.

CONCLUSION

Mr. Chairman, I hope that this overview provides a sense of the problems we are facing and the strategy we have chosen to address them. We are encouraged by the budget request level that the President has sent forward. We, of course, believe that science and engineering are keys to the future well-being of our country. I hope that the final action taken by the Congress on the National Science Foundation's FY 1987 Budget Request will help us ultimately to provide those keys for the Nation, and we ask for this Committee's support toward that end.

Mr. BOLAND. Thank you very much, Mr. Bloch, for a fine statement and also the charts that you have provided for the Committee. We have a serious problem this year, of course; one of the problems we have is to defend this kind of a budget when it gets to the floor in relation to all the other budgets that this committee and the other Subcommittees of the full Appropriations Committee considers.

I think that one of the departments that we handle in this committee has taken probably some of the most drastic cuts in programs. Yet, even after the application of Gramm-Rudman in 1986, the Foundation's 1987 budget is up by almost 9 percent, isn't it?

Mr. BLOCH. It will go up, yes. That is correct.

BALANCE AMONG COMPETING AGENCIES

Mr. BOLAND. That compares with a reduction from about \$10 billion to zero for one of the important programs that we handle here in this committee, subsidized housing. I don't have to tell you then this Committee has been a very strong supporter of the NSF during the long period of time that I have served on it both as a member and as chairman.

I don't know of any other Committee that really has been a stronger supporter, particularly with reference to basic research. We have also made an effort to balance the reductions needed to meet the severe deficit problem; the Administration, I think, has thrown that balancing effort entirely out of whack compared with some of the other programs with which we deal in this Committee.

Somehow that doesn't seem to be fair. That is supposed to be one of the buzz words of a budget that is supposed to strike a fair balance among the competing Agencies, Departments, and Commissions that go into the Budget. You don't seem to be affected at all by the need for overall economy.

Your budget does not appear to be affected by that. What about it? Why should we approve a 9 percent increase for the Foundation and cut some of the other programs in other Agencies that this Committee deals with to zero?

Mr. BLOCH. Mr. Chairman, this is a very difficult question and whatever I say it might sound self-serving, but that is the nature of the question that you are asking. I want to just suggest a few things. First of all, there are many problems on the table, no doubt about it.

One of the problems that we are facing as a country is economic competitiveness. I think it is a war. We are fighting as much of a war as any war, any real war that we fought in the past. I think one of the very important aspects of that economic competitiveness has to do with educating our people, with doing the basic research that is required, with putting facilities in place so that one can do that particular research because what will flow from that is the essential wherewithal to compete in the future.

Now, basic research, and science research and engineering research, is a long-term investment. The results are not available the next day. It is not the nature of this particular endeavor.

So I think we have to continually invest in it. We can't afford to leave a generation behind and not provide for that generation's

education and/or skip a particular evolution and activities in a particular science area. So we are faced with a very severe problem called economic competitiveness.

The biggest contributor to its solution, to staying competitive, is people, science, and education. I think we cannot afford to sit by one year or five years and let an opportunity go by, because you never make up for lost time. That is what I would suggest.

LOSING THE COMPETITIVE EDGE

Mr. BOLAND. It all sounds very good when you are talking about economic competitiveness. We are in competition with other nation's industrialized capability and the impact that has upon our domestic economy because these foreign industries are contributing to de-industrialization of the United States.

Is that a fear that the Board looks at?

Mr. BLOCH. Sure.

Mr. BOLAND. This has been raised a number of times, that we are losing our competitiveness in the manufacturing end, in the industrial end. We are now developing into a service economy where we don't import services very much or, if you do, you don't get much for them.

Mr. BLOCH. I think we should not be satisfied with becoming a service economy because, as you say, a service economy has a different kind of *modus operandi*. I am very concerned that we give up that easily on being an industrial power, that we give up too easily on keeping the industries here in this country.

I think the pressures we are seeing today, the advances that are being made overseas by a number of our trading partners, rely fairly heavily on the basic research that has been going on in this country.

But let's not underestimate them. They are also building up their own research capabilities. So I am not at all satisfied with the fact that as some say, we have gone through the industrial era and are leaving that behind and going now into a service economy.

There would be competition in the service areas, too. It is too easy to have too many of the services come from wherever. I think, number one, that we should not give up on keeping industry here. Number two, even in the service area we will be confronted with world competition, and whatever we can do to protect our future in that particular area by doing the work today, by training the people today, is very important.

Mr. BOLAND. Well, again, one of the great fears is that there is a tendency towards de-industrialization and we are creating hollow industries where we actually get the parts from foreign nations, assemble them here and that is that. I think that is having a serious impact upon the ability of this nation to survive economically.

Mr. BLOCH. I agree with you and the "Business Week" article a couple of weeks ago was frightening in that regard. It has also another parameter to it.

We are depending very heavily in many of our activities like defense on a domestic industry and if we are losing those industries like semiconductors, which is one of the ones that over a short period of time has turned around from a net exporter to a net im-

porter, if we are losing that particular industry, we are at the mercy of other countries. I don't think we should be at the mercy of those countries.

FY 1987 FEDERAL R&D

Mr. BOLAND. Getting back on the ground, with reference to the budget itself, I am sure that you have some thoughts about whether or not all agencies of the Government should share in the burden of balancing the budget. Perhaps they should not share in a straight across-the-board reduction, but at least in some of the burden.

With reference to Federal research and development, the President's fiscal year 1987 budget increases that particular activity by 16 percent, up \$8.7 billion above the current funding level of \$53.8 billion. Of that amount, 70 percent is funded in the Department of Defense. What do you think of that mix?

Mr. BLOCH. Well, let me say first something about the National Science Foundation. We are sharing in the burden.

In 1986, as I said before, our net budget over 1985 is minus three percent. We took the Gramm-Rudman reduction last week just like everybody else. So we are sharing it.

Now, when you turn to the increases in 1987, yes, our budget has been increased. So has that of other Departments. You mentioned Department of Defense and that is the President's decision. I think many of the areas in the Defense budget also address research and development.

I wish more of that Defense budget would address basic research rather than development. If you analyze it, you will see that the basic research part of the Department of Defense budget is not seeing the increases that the total R&D budget of the Defense Department is seeing.

I, for one, would have liked to see more going into the basic research area because it would help us in what the National Science Foundation is all about and what the NSF is supposed to do.

Mr. BOLAND. I think you are making a good point. Let me ask, of the \$62.5 billion requested for research and development in 1987, how much is basic research? Of that amount, how much does the Foundation fund?

Mr. BLOCH. Of the \$62.5 billion, basic research is about \$8 billion. We are funding about \$1.5 billion of that. So the basic research is a small portion of the total.

In addition, I want to point out that of the \$8 billion for basic research only about \$4 billion is for basic research in universities. In addition, the private sector basic research is not adding much to the total.

IMPACT OF GRAMM-RUDMAN ON 1987 EMPHASES

Mr. BOLAND. The President's 1987 budget document indicates after the application of Gramm-Rudman in fiscal year 1986, the current services level for National Science Foundation is \$1,516,000,000 in fiscal year 1987. NSF's budget has identified three areas for special emphasis.

They are biotechnology, which is in for a \$20 million increase above the base level of \$86.5 million in 1986; computational science and engineering, which is asking an additional \$27 million above the base level of approximately \$57 million in 1986; and global geosciences which seeks an increase of \$18 million above a base level of approximately \$17 million.

Now, keeping in mind the \$1,516,000,000 for the current services level, if your 1987 appropriation is at or about that total, would you reduce other activities in the Foundation to maintain your three priority areas at the requested levels?

Mr. BLOCH. Well, that is a difficult question to answer, but let me say the following. I would like to maintain some level of effort in those three areas that you identified. By the way, there is a fourth area which I talked about before, namely, broadening participation in science which is equally important, has an equal footing with the other ones, but I would want to say that we probably would like to see these four areas continuing to see an increase, though probably not the same increase that we are proposing.

But the point which I made last year and which I want to make again this year is that we spent a lot of time on this particular budget. It has all kinds of balances in there between various disciplines, between various ways of doing research, between people and research, and if one eliminates from the budget certain dollars then I think one has to re-think the balance again.

But I would like to say categorically, we would like to keep those three areas with an increase, but probably not the same increase.

LOWER PRIORITY ADJUSTMENTS

Mr. BOLAND. On page NSF-2, you indicate that in stressing fiscal responsibility, you are phasing down or terminating activities of lower priority, or lesser promise. But on page NSF-15, the budget detail is outlined by activity and sub-activity and it is difficult to find a single sub-activity showing a decrease in 1987.

That is true, isn't it?

Mr. BLOCH. Yes, that is true.

Mr. BOLAND. That is true, isn't it, Sandra?

Ms. TOYE. Yes, it is true.

Mr. BLOCH. Let me explain what that statement means, and how we went about it in one budget exercise. Before we went into the budget exercise for 1987, every directorate went through an identification of the lowest 8 percent of priorities by dollars for their areas.

This was subtracted from the base. The eight percent freed up, plus the new dollars, were then taken and redistributed to the various functions and directorates in order to create the budget you see, including the new thrusts.

So you will not find that eight percent redirection defined in this budget submission, but we went through that exercise, we took the eight percent that we freed up by this prioritization and combined it with the new dollars to construct the budget that you see.

Mr. BOLAND. What we need is a little help on this side of the table when we sit down and mark the bill up. Let me suggest this and, again, referring to page NSF-15 and assuming roughly a cur-

rent services level of \$1,520,000,000 in fiscal year 1987, will you provide for the record, using the stub column on that page, how you would allocate your resources at that appropriated level?

Mr. BLOCH. Sure.

[The information follows:]

ALLOCATION OF RESOURCES AT FY 1987 CURRENT SERVICES LEVEL

In effect, the post G-R-H current plan for 1986 (attached) would be a reasonable starting point for allocation at the current services level proposed by the Subcommittee for 1987. The post G-R-H 1986 current plan totals \$1.458 billion, which rises to \$1.489 billion with the addition of the \$31.45 million carryover in Science and Engineering Education. Inflation of as little as 2% brings the sum to the \$1.52 billion level proposed by the Subcommittee.

Such a proposed level for 1987 would have a far-reaching impact on the scientific and engineering communities that look to the NSF for support. I described some of these effects in an Important Notice (No. 100) I sent to Presidents of Universities and Colleges and Heads of Other NSF Grantee Organizations on February 13, 1986: renegotiate increments on continuing grants; eliminate Principal Investigator salary support; limit indirect cost rates, or some components of indirect costs; and larger cost-sharing requirements.

From a programmatic standpoint, we would have to carefully re-evaluate our 1987 program, almost on a case-by-case basis, for its effects on 1987 and beyond. We would examine each of the areas of emphasis set forth in the President's proposed budget for NSF and determine the extent to which some of them might be accomplished by trade-offs against the ongoing current service program, including the possible phaseout or shut-down of large facilities, centers, and the like. All of these decisions would require detailed review by the Foundation, discussions with advisory groups and the National Science Board, and consultation with OMB and Congress.

26-Mar-86

SUMMARY BUDGET INFORMATION
BY ACTIVITY AND SUBACTIVITY
GRAMM-RUDMAN-HOLLINGS IMPACT

ACTIVITY	CURRENT PLAN NOA FY 1986	REVISED 1/ CURRENT PLAN	DIFFERENCE
MATHEMATICAL AND PHYSICAL SCIENCES			
Mathematical Sciences	\$51,740,000	\$51,740,000	\$0
Computer Research	40,170,000	38,231,552	(1,938,448)
Physics	118,630,000	112,903,379	(5,726,621)
Chemistry	89,780,000	85,447,567	(4,332,433)
Materials Research	109,650,000	104,358,710	(5,291,282)
TOTAL	\$409,970,000	\$392,683,216	(\$17,286,784)
ENGINEERING			
Engineering Science in Chemical, Biological, and Thermal Engineering	29,180,000	27,771,007	(1,408,113)
Engineering Science in Mechanics, Structures, and Materials Engineering	23,700,000	22,556,330	(1,143,670)
Engineering Science in Electrical, Communications, and Systems Engineering	25,700,000	24,459,810	(1,240,182)
Science Base Development in Design, Manufacturing, and Computer Engineering	18,700,000	17,797,611	(902,389)
Fundamental Research in Emerging and Critical Engineering Systems	36,195,000	34,448,370	(1,746,630)
Cross-Disciplinary Research	29,000,000	27,600,573	(1,399,427)
TOTAL	\$162,475,000	\$154,634,590	(\$7,840,410)
BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES			
Molecular Biosciences	61,930,000	58,941,500	(2,988,500)
Cellular Biosciences	52,130,000	49,614,409	(2,515,591)
Biotic Systems and Resources	61,020,000	58,075,413	(2,944,587)
Behavioral and Neural Sciences	45,690,000	43,485,179	(2,204,821)
Social and Economic Science	30,040,000	28,590,387	(1,449,613)
Information Science and Technology	9,260,000	8,813,148	(446,852)
TOTAL	\$260,070,000	\$247,520,035	(\$12,549,965)
ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES			
Astronomical Sciences	84,220,000	80,155,871	(4,064,129)
Atmospheric Sciences	96,780,000	92,109,774	(4,670,226)
Earth Sciences	48,940,000	46,578,346	(2,361,654)
Ocean Sciences	124,030,000	119,436,984	(4,593,016)
Arctic Research	8,520,000	8,108,858	(411,142)
Total	\$362,490,000	\$346,389,834	(\$16,100,166)
SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS			
Industrial Science and Technological Innovation	15,760,000	14,999,484	(760,516)
International Cooperative Scientific Activities	10,840,000	10,316,904	(523,096)
Policy Research Analysis	1,940,000	1,846,383	(93,617)
Science Resources Studies	3,940,000	3,749,871	(190,129)
Research Initiation and Improvement	6,990,000	6,990,000	0
Total	\$39,470,000	\$37,902,642	(\$1,567,358)

1/ Revised Current Plan reflects Gramm-Rudman-Hollings reductions, plus
Reprogrammings approved by the Committee affecting Mathematical Sciences,
(MPS), Ocean Drilling Program (AAEO), Visiting Professorships for Women and
Research Improvement in Minority Institutions (STIA), and Program Development
and Management.

SUMMARY BUDGET INFORMATION
BY ACTIVITY AND SUBACTIVITY
GRAMM-RUDMAN-HOLLINGS IMPACT
(Continued)

ACTIVITY	CURRENT PLAN HOA FY 1986	REVISED 1/ CURRENT PLAN	DIFFERENCE
Advanced Scientific Computing	\$45,230,000	\$43,047,368	(\$2,182,632)
Program Development and Management	72,500,000	71,882,500	(617,500)
Total, Research and Related Activities	\$1,352,205,000	\$1,294,060,185	(\$58,144,815)
U.S. ANTARCTIC PROGRAM			
U.S. Antarctic Research Program	11,500,000	11,005,500	(494,500)
Operations Support	103,600,000	99,145,200	(4,454,800)
Total	\$115,100,000	\$110,150,700	(\$4,949,300)
SCIENCE AND ENGINEERING EDUCATION			
Research Career Development	27,300,000	26,126,100	(1,173,900)
Materials Development, Research, and Informal Science Education	9,250,000	8,852,250	(397,750)
Teacher Preparation and Enhancement	11,500,000	11,005,500	(494,500)
Studies and Program Assessment	2,000,000	1,914,000	(86,000)
College Science Instrumentation	5,500,000	5,263,500	(236,500)
Total	\$55,550,000	\$53,161,350	(\$2,388,650)
Special Foreign Currency Program	1,000,000	957,000	(43,000)
TOTAL, NATIONAL SCIENCE FOUNDATION	\$1,523,855,000	\$1,458,329,235	(\$65,525,765)

1/ Revised Current Plan reflects Gramm-Rudman-Hollings reductions, plus
Reprogrammings approved by the Committee affecting Mathematical Sciences,
(MPS), Ocean Drilling Program (AAEO), Visiting Professorships for Women and
Research Improvement in Minority Institutions (STIA), and Program Development
and Management.

PEER REVIEW

Mr. GREEN [presiding]. A recent *New York Times* article reported on a study by Dr. Steven Lock who is editor of the *British Medical Journal*, which challenged the peer review system as it now operates. He claimed it needed improvement, and suggested reviewers are often too subjective in their work, that they subject other's work to criticism to which they would never subject their own.

I don't know if you are familiar with his paper. Would you care to comment?

Mr. BLOCH. I have read that same article. I think he referred primarily in that article to peer review of scientific papers. But sometimes I hear the same comments on peer review of research projects.

Mr. GREEN. You had a study some years ago which indicated some problems in that different groups would come out different ways on the same publications.

Mr. BLOCH. We have had many studies and you should know at the present time there is a committee in place under Dr. Norman Hackerman to look at the peer review system as it is being used in the National Science Foundation. Norman Hackerman, as you know, is the President Emeritus of Rice University, and former Chairman of the National Science Board, so he is very well versed in this particular area.

The reason why we put that committee in place a few months ago was some of the criticism that you are citing. You can hear all kinds of criticism from all kinds of people, especially people that didn't make out too well in the peer review system, but not exclusively.

I think any system has to be looked at from time to time to see how it can be improved, to see how it performs, and then make the necessary corrections and changes. We are going to do that, when we see the report of this particular committee.

Some of the issues that one hears is that peer review it is an old boy network; that is one criticism. The second one is that it is not prone to accept revolutionary or new ideas; and the third one is that it is very difficult for the peer review system to come to grips with multi-disciplinary kinds of projects, programs and grants. There is something to all of that, I think, and that is why we want to take a good look at it, but it is still the only system that we have that gives us the excellence and the quality assurance that what we are doing and how we are spending the taxpayer's money is really worthwhile.

So we have to make sure that that system works better and stays in place. It is the only system we have.

MANUFACTURING RESEARCH

Mr. GREEN. If I can move to an issue you raised in your presentation. That is the question of industrial competitiveness. There was a story in the paper today about probable future reliance of the Pentagon on certain high technology products from Japan. I can recall we discussed this at last year's hearings and particularly the issue of how we move from the R&D to the production end of things, and whether we don't need more research into production

methods because so often it seems we do, in fact, do the basic R&D, but that other countries, and particularly the Japanese, seem to be able to out-produce us in our own research product. What is NSF doing to encourage improved production technology in this country?

Mr. BLOCH. We are doing quite a bit in this particular area. In fact, if you look at the university engineering research centers, I believe all of them, maybe with the exception of one, have to do in one form or another with manufacturing research and manufacturing technologies, be it in the preparation of materials like ceramics and composites or be it in an area like robotics. So engineering research centers are focusing on that area.

Let me say one thing about it. I think that we probably have been negligent—not only probably, but we have been negligent in the past in that manufacturing research and problems associated with manufacturing have not been looked at as an acceptable academic discipline.

That was a mistake. I think today the universities are rectifying that situation. A few years ago when one looked around and asked the question what kind of graduate programs were in existence on manufacturing systems in universities, there were probably two or three. Today, one can count 30 or 40.

That just shows that this particular engineering area is being looked at today as much more important than it was in the past, and that universities are finding that it is a challenging and very important area and they are stressing it.

FOREIGN STUDENTS IN SCIENCE AND ENGINEERING

Mr. GREEN. In a related issue, let me turn to the item you raised about the high percentage of foreign students that we are educating in the technical disciplines in our colleges and universities. *Science Indicators* in its 1985 report issued by the National Science Board, shows that over half of the engineering Ph.D.'s given each year go to foreign students, but less than 28 percent of these students take up employment in the United States; at the same time less than two percent of our engineering students seek higher degrees from other countries.

In a sense, then, we are subsidizing technology transfer through this education process to these other countries. Now maybe in terms of third world countries one can see that as a very valuable kind of thing for the United States to be doing, but have you taken a look at how many foreign students are being supported on NSF grants and contracts? How does this affect your competitiveness?

Mr. BLOCH. Well, I have a few comments on that.

Mr. GREEN. It cuts both ways.

Mr. BLOCH. That is exactly right. This is not a one-way kind of give away.

Mr. GREEN. You don't know which 28 percent is going to stay and which will go.

Mr. BLOCH. The 28 percent bothers me. The number that I know of, especially in the engineering area, is more like 60 percent that are staying here and I think that is probably a more accurate number, wouldn't you say so?

Mr. SUH. Yes.

Mr. GREEN. If for the record you could reconcile that.

Mr. BLOCH. I will reconcile that and put in the record the actual data.

[The information follows:]

FOREIGN STUDENTS PLANNING TO REMAIN IN THE UNITED STATES

The data from p. 21 and p. 209 of Science Indicators: The 1985 Report show that in 1983, 25 percent of foreign, non-resident new Ph.D.'s in science and engineering fields, who expressed firm plans for the future, said they expected to be employed in the United States. Another 18 percent of this group said they expected to be engaged in postdoctoral study in the United States. These numbers together yield a total of 47 percent who intend to stay in the United States. The comparable numbers for Ph.D.'s in engineering fields only are: 42 percent expecting United States employment, 14 percent expecting United States postdoctoral study, for a total of 56.1 percent expecting to stay in the United States.

An important caveat must be observed in interpreting these data: only 60 percent of foreign, non-resident Ph.D.'s, actually expressed firm plans for the future. We have no idea where the remaining 40 percent were headed.

Mr. BLOCH. If 60 percent are staying here, it is a different situation than 28 percent. But here is the point I wanted to make and that I made in the statement. I have no problem with that at all.

In fact, I think it helps us in attracting people to the work force in the United States. My concern is more with an over-dependence on that particular resource and if that resource should be cut off tomorrow, like it has been in the past. Just think of Iran and the Iranian students that took up engineering and some of the sciences here. From one day to the next that flow was cut off. That could happen to us elsewhere.

So that is my concern, our over-dependence on that resource. If you look at some of the Ph.D. areas and the disciplines for which Ph.D. degrees are granted, you will find essentially that a very small number of American students are going for the Ph.D. now.

It is becoming a non-American activity almost and I don't think we can let that happen because that has a lot to do with the future of the country. So I am concerned about it for that particular reason.

Then in addition to that, if you look at the picture including foreign students, you will see that our Ph.D. production is declining. In computer science we are producing 200 Ph.D.'s a year. This is in a new field, a field that is pervading all the other sciences and also industry; that is why we have shortages in faculties.

That is my concern.

Mr. GREEN. Is it the case in computer sciences, as I am told it is in other science disciplines, than it is because of the very high pay that people who have graduate degrees can get?

Mr. BLOCH. Yes.

Mr. GREEN. What can we do to address that?

Mr. BLOCH. What we can do and what we have been trying to do is support the Ph.D. track more than we are doing today with grants, with special programs and so forth. As you know, the Presidential Young Investigator Program was established to attract people into faculty positions and on keeping them there. In that

program we have definitely focused on those disciplines that are in short supply.

That is why engineering has 50 percent of the positions in that particular area.

FOREIGN ACCESS TO SUPERCOMPUTERS

Mr. GREEN. Just so you will know what I was referring to, it is the National Science Board *Science Indicators* 1985 report, the chart on page 21. A recent *New York Times* article reported on a decision reached by you at the urging of the DOD to restrict the access the Soviets have to U.S. supercomputers; there was implication in that article you reached the decision rather reluctantly.

I was wondering if you would care to comment on the problem?

Mr. BLOCH. I haven't reached any decision at all. In fact, let me tell you what the situation is. There have been conversations over the last few months on this particular issue with both DOD, Department of State, which has a stake in this issue, and with the National Science Foundation, and a discussion with some of the universities that are concerned with it, because they have some of the supercomputer centers. The status is the following.

I think we will have to put in place a regime that controls access to supercomputers because our allies have done that and are doing it and we are committed to do the same. The question is how one can make that regime acceptable to the universities without distorting the function of the universities and our proposition has been reasonable and simple.

First, the Government has a right to grant visas or deny visas. It can deny a visa to a particular individual that it does not feel is trustworthy to come into this country. That is the Government's problem, not the university's problem.

The Government has a right to restrict the movement of an individual who can enter the country and, therefore, has a right to restrict access to supercomputers by special prohibition on the visa and that, again, is the Government's prerogative.

What we suggest, and that is where we have the problem, because we have not resolved it, is that while that right is acknowledged, we would like to see a provision where the individual who is affected by the restriction has recourse, can be heard and an exception granted.

The Government can again decide yes or no. So we want to have that provision in the regime.

The second exception that we want to have is for students that are taking educational courses in supercomputers. There are very few courses today, but the day will come when there will be more. We believe that for those students who are admitted to this country to study, and are taking educational courses, there should be no restrictions in their access to the equipment.

In other words, whether a student is an American citizen or not an American citizen, he should have right of access to the supercomputer if it is part of the course work. We want to have that one clearly understood.

There is disagreement on both of these issues I just cited. The third one, where there is no disagreement, is that the normal pro-

visions of controlling access to supercomputers, pass words, peer review of the time allocated to an individual, are sufficient to control the access to supercomputers in university environments so that it does not put any extra burden on a university computer center.

There is agreement on that, so we have a disagreement on two aspects of it, and the disagreement is still in existence today.

IMPACT OF DOD R&D FUNDING

Mr. GREEN. Let me turn to another aspect of relations with DOD. In 1979, DOD's share in the R&D budget was about 49 percent. It is proposed in fiscal year 1987 it be about 70 percent. Can you describe the impacts that this shift in Federal support, or the departmental origin for Federal support, for R&D has on research areas? What about the allegation that the increase in defense needs, particularly the SDI program, is going to drain professional personnel from other areas of R&D important to the country?

Mr. BLOCH. Let me talk about the last point first. I have less of a concern about that.

You know, that has been said in the past about some of the big programs that we undertook as a country. It has been said about the space program that it would drain people away from other kinds of research, especially industrial kinds of research; but the system is robust enough that it can accommodate itself to these changes.

So I don't have much of a problem with that. I suspect that again we are exaggerating that particular aspect. Now, when it comes to what effect the Department of Defense increase from 49 percent to 70 percent would have on research in general, the point I made before is essentially the one that I want to repeat here, namely, that the basic research part of that particular budget is being reduced as a percentage of the total.

I consider that a very serious situation. More and more the Defense Department's R&D dollars are going into development rather than the research part of it. If the balance had stayed the same, there wouldn't be a problem from my end, because basic research, especially basic research in universities, but not only universities, serves everybody.

The fall-out from civilian research into defense is probably as great or maybe greater than fall-out from Defense into the civilian sector and industry.

INDIRECT COSTS

Mr. GREEN. Let me turn to OMB's circular A-21, relating to the capping of administrative indirect costs of colleges and universities at 26 percent beginning on April 1 of this year. It is dropping down to 20 percent on April 1, 1987.

What do you think the impact of this is going to be for NSF and the agencies it funds?

Mr. BLOCH. This is under discussion right now. In fact, as you know, OMB has asked for comments by March 15 which is a few days away. I am sure what you are going to hear from the universi-

ties is that this will cause a lot of problems. Let me tell you where we stand right now on that, and we haven't concluded.

I think it is probably right that one caps the administrative portion of the overhead or indirect costs. Twenty-six percent going down to 20 percent is as good a number as any. Let me say one thing, however.

I would like to see it not only capped, but make that a fixed number for everybody, so that we are getting out of this problem of negotiating and accounting for that expenditure and, therefore, can reduce the indirect cost even further. I don't think at that particular level it matters too much if somebody spends 25 percent or 26 percent or 22 percent versus 24 percent.

You are talking about small differences. So that is point number one. I would like to see it as a fixed number rather than as a cap so we can get rid of some of the reporting that is very onerous on PIs and does not do anybody much good.

The second thing is that by taking that reduction we are not recognizing that there are other problems that universities have which we have neglected in the past, namely, the equipment problem and the facilities problem. If at the same time we take something away from the administrative portion of the budget, we could give something back to the universities, that would put them into a better position to refurbish their facilities and their equipment in a timely way. We should by allow higher allowances for depreciation and recovery, and then I think we would make a very major step forward.

Administrative indirect cost reduction by itself, I think, will cause problems and not solve some of the other ones; a combination of the two, I think, would help.

Mr. GREEN. I have, indeed, heard from the University Presidents in New York City. One of the things they complain about is the large amount of paper work they get from the Federal Government which they insist is driving up these indirect costs. I note in the December, 1985, *Federal Register* the burden that is needed now to fill out NSF forms was put at \$4,200,000. Obviously, even at \$20 an hour, that is a lot of money people are expending. If you look at these when they come in, you must be spending a fair amount of staff time and have a considerable overhead burden, too.

Of course, you are going to have to be audited. Doesn't this seem a lot of time and money for the task?

Mr. BLOCH. Let me tell you, we are very sensitive to that particular problem. In fact, we are running an experiment right now together with some of the other agencies, DOE and NIH, and so forth, in the State of Florida, which applies not only to the State universities, but also to private universities in the State to reduce the paper work, to reduce bureaucracy, to reduce some of these ominous obligations that we are putting on people.

That experiment has started and from that, I hope we, will learn a great deal. Then we can use it in the rest of the country. Let me make one comment, however. Yes, the Government puts a lot of restrictions and requirements on people, but universities and States do the same. I suspect we will learn in that experiment in Florida that when we remove some of the bureaucracy that the Federal

Government is responsible for, the next one that is going to show up is the State bureaucracy; that may also need reform.

After that is eliminated, universities are doing a lot of bad things to themselves and hopefully that can be removed also. So we have the push on reducing bureaucracy.

Mr. GREEN. Mrs. Boggs, do you want to ask anything?

Mrs. BOGGS. If Dr. Bloch will be here tomorrow, I can wait until then.

ENGINEERING RESEARCH CENTERS

Mr. GREEN. Mr. Coughlin.

Mr. COUGHLIN. Thank you, Mr. Chairman.

Could you explain the engineering research centers program? I was interested in how the Federal monies are leveraged from private capital and industrial resources and what the anticipated ratio of public to private funds is for fiscal year 1986.

Mr. BLOCH. As you know, engineering research centers have a provision in it that the university has to leverage not just the dollars but the activities, by essentially enlisting private funds for it, or by putting some of its own money in it, or getting money from the State.

Of the five or six centers we have in existence today, we have about \$13 million that is being leveraged from other sources against these particular centers. I am not saying that will be for 1986 only and there will be \$13 million again next year.

I am not saying that. What I am saying is essentially we have attracted about \$13 million in equipment and money and other services into these particular centers. I would hope that that would continue in a significant form.

The centers are only building up now so it is premature to say how much the leverage will be in this situation. They have only been in existence for nine months. I visited an ERC center at MIT, and that is a biotechnology center, where they have about 22 companies that have signed up. It costs money to sign and to participate in that center.

So we can see or we can expect over the years that these centers will attract an increasing amount of funding from other sources than the Federal Government.

Mr. COUGHLIN. Can you cite some companies that are participating in this?

Mr. BLOCH. Yes. The ones in the MIT area were mostly from the chemical industry. Included were DuPont, Monsanto, Dow, a lot of the smaller companies, Genentech, and some that have a specialty product relationship; there were a large number. Maybe Dr. Nam Suh wants to add to that one. He is the assistant director of engineering that is in charge of this particular program.

Nam.

Mr. SUH. I cannot at this time furnish you with the exact 22 names that you just got last week. We do not have up-to-date information, but I think it is important to mention that for the \$10 million we invested last year, these university centers could raise \$13

million. This is quite a significant leveraging over a period of nine months.

Furthermore, if our past experience with our university-industry cooperative research center program is any indication, then I think leveraging in the future years would increase substantially. For a \$3 million investment we are making annually, they are raising \$26 million from other sources. This is a substantial leveraging of NSF funds; my feeling is that that trend will continue.

In fact, in the case of MIT's biotechnology center, my feeling is that most of the companies cannot afford to stay out of the MIT center, because if they stay out of it they may be missing some of the major opportunities that are being developed in the field. So I have a feeling most of the drug companies and most of the major chemical companies interested in the agricultural products would be in it. My feeling is a large number of small biotechnology firms will be participating in the MIT center.

Mr. COUGHLIN. What area of special emphasis in your fiscal year 1987 budget is getting the largest increase in funding?

Mr. BLOCH. The largest increase on a percentage basis, do you mean?

Mr. COUGHLIN. Dollar basis.

Mr. BLOCH. Computational sciences. Computational sciences, by the way, is not a stand-alone program. It is distributed throughout all the directorates because in each directorate and in each special discipline there is a need for computational sciences and engineering.

SUPERCOMPUTERS

Mr. COUGHLIN. You talked about your supercomputer programs earlier. Can you explain how this is accessed and the location from which it is accessed?

Mr. BLOCH. Yes. By the way, the supercomputer center program is another program that we are leveraging very extensively through industry funding, primarily of manufacturers. For every Federal dollar spent a year, about 60 cents is being spent by the universities from State and industrial sources. So it is a highly leveraged program.

There are five centers in existence; what we are now trying to do, and what we have been doing, is extending in a significant way in 1987 and beyond the network that not only interlinks those five centers, but also makes the five centers more easily accessible by universities that don't have supercomputers of their own.

Many of these centers already have 18 to 20 universities associated with the center. The network that we are putting in place is based on existing networks and will give easy access to the user no matter where he is in the country.

In order to do that, we have to put in place a network of communication lines. You have to have a protocol which is understandable and available to various computers of different makes and to various work stations of different makes; we are going to spend much of our effort on making that network become a very efficient one and also link into it more universities as time goes on.

Mr. COUGHLIN. Where are the five centers located?

Mr. BLOCH. One is in San Diego, one at the University of Illinois in Urbana, one at Princeton, one in Pittsburg and one in Cornell. There is a supercomputer center also at NCAR in Boulder, which has been in existence for some time. It will also be linked in with the other five centers in the network I described.

ATTRACTING MINORITIES AND WOMEN TO SCIENCE

Mr. COUGHLIN. Turning for just a minute to education and then I will yield. Over the years we have seen a lack of minority and female students enrolled in scientific disciplines and engineering. As your funding has increased, have your efforts to attract minority students increased and how successful have they been?

Mr. BLOCH. We are focusing on minorities very heavily, minorities and women. Your comment applies to women also.

We have special programs that are addressing this particular area. How successful have the programs been? I think the programs we have put in place have been very successful.

They are not very large programs. They are small programs, but they are aiming at making it easier for minorities and women to participate in research and then become self-sufficient, and stand on their own feet.

I think the programs that we have, like the minority initiation research programs and the improvement in minority institution programs, are geared to that end and I think its successes have been significant. In fact, the yields in these programs are better than the yields we have in the rest of the programs at the Foundation.

So I think it has been highly successful. If you look at the total story—and from these programs alone you can't really see—the increase that has occurred over the last 10, 15 years of women participating in engineering has been really gratifying but on the other hand it is leveling off.

It is leveling off at a low number. In the area of minorities, one has to differentiate between various minorities. The Asian and Oriental minority groups are doing pretty well.

Blacks, in some of the areas, are not doing as well, and so it is a mixed bag and we have to keep our focus on these programs. By the way, you should know that within the Gramm-Rudman decrease, we exempted these programs from the reduction.

We didn't take any money away from these programs. We took it away from the rest of our programs. We protected the minority programs and women programs as well as the EPSCOR programs which open up States to research activities that today are not participating.

So we protected all of these programs.

Mr. COUGHLIN. Thank you, Mr. Chairman.

PRIORITIES IN FY 1986

Mr. GREEN. Let me follow on with some on the Gramm-Rudman and fiscal year 1986 issues. Could you tell us a little bit about how you chose the programs?

You mentioned the women and minority programs, ocean drilling and also mathematics. Could you tell us the basis of your selection?

Mr. BLOCH. Let me take mathematics as an example. Here is a discipline that we neglected in the past. Over the last couple of years we have tried to rectify that situation by giving it significant increases, percentage increases in 1987, just like mathematics got the big increase in 1986 and 1985. With the 4.3 percent cut we didn't feel we should undo everything we had been doing very carefully, so we protected mathematics.

The ocean drilling area is a little bit different, it is a going rate situation. As you know, we have had successes in having other countries join that particular program.

England just joined a few weeks ago. We have high hopes that the European Science Foundation will join the program. This combines a large number of small European countries and if that happened, then we would come in for a reprogramming but on a going rate basis we can not cut that program right now.

So that was on ocean drilling. In general, we tried to protect people, I mean students, graduate students and undergraduate students, by asking the universities, asking our program managers to focus on a reduction in the salary area, PI salary area, or on overhead.

Mr. GREEN. This was the Important Notice Number 100?

Mr. BLOCH. In the graduate fellowship program, we did not reduce the number of graduate fellowships that we had planned on. That is about 1500. We did not reduce the \$11,000 stipend.

We took a 12 percent reduction from the educational allowance, reducing that from \$6,000 to \$5250. This was done for the same reason that I mentioned before. We have a problem attracting enough people into science and engineering and now because of an adversity like Gramm-Rudman, if we take dollars away from this area, that does not seem to be right. That does not protect the future competitiveness of the economy.

BEHAVIORAL AND SOCIAL SCIENCES

Mr. GREEN. In contrast, the 1986 budget was cited for significant increases for Behavioral and Social Sciences, but between the Congressional action and the Gramm-Rudman-Hollings reduction, by now those proposed increases have really just about disappeared.

Mr. BLOCH. Not quite, but it is getting there.

Mr. GREEN. Your fiscal year 1987 request proposes rather small increases for those areas. Why do these areas seem to be less of a priority?

Mr. BLOCH. I don't know if they are less of a priority, but when we submitted the 1986 budget it had a significant increase, about \$5 million, which was aimed primarily at the quantitative disciplines and activities of the behavioral and social science areas.

It got whittled down first because we didn't get the total money from Congress and then 4.3 percent was cut on top of it. Still we have something left in 1986. The 1986 budget over the 1985 budget is not a flat budget by any means, and therefore going into 1987, the in-

crease is not of the magnitude it was in 1986. Again, it is a balancing act between what is required here and what is required in other parts of the Foundation.

Mr. GREEN. Are the social and behavioral sciences beneficiaries of any of the fiscal year 1987 special emphasis programs in biotechnology?

Mr. BLOCH. Definitely. The computational science and engineering program has a great input from social and behavioral sciences and biotechnology.

Ms. TOYE. Geosciences, as well.

Mr. BLOCH. There is a lot of that in there.

Mr. GREEN. That would be your emphasis on the social sciences in the fiscal year 1987 program, or are there others?

Mr. BLOCH. What you see the budget would be plus the participation in the special emphasis area, is the sum total of the social and behavioral sciences program.

Mr. GREEN. Do you have any plans for interdisciplinary areas that would include social and behavioral sciences?

Mr. BLOCH. Yes. All the engineering research areas in one form or another include social and behavioral science disciplines. How well the universities are going to address this, is something that I have concern about and will keep focusing on. Let me just mention a number of obvious connections.

Human factors are very, very important in many of the engineering disciplines. That is a social science. If you look at the whole area of economics, the whole area of systems design and systems approaches in engineering, it requires a heavy grounding in economics.

So I would think that there are many areas in which social and behavioral sciences would contribute and can participate in the engineering research centers. The whole area of risk analysis that one hears about with regard to biotechnology, is one area I think that involves approaches from the behavioral and social science disciplines.

So I would expect a great amount of participation. I can't quote you any numbers right now, but we are looking at that and we will keep our focus on it.

UNDERGRADUATE INSTITUTIONS

Mr. GREEN. Last year the Chairman of the Subcommittee asked the Foundation to review its role with respect to support for undergraduate institutions. I understand that is still under preparation and we look forward to its completion.

I believe the support for undergraduate institutions is a responsibility that has to be shared by most of the programs included in the Foundation. Would you please highlight the Foundation's plans for the support of undergraduate institutions in the fiscal year 1987 budget request?

Mr. BLOCH. Yes. First of all, let me assure you that the report that has been asked for is being worked on. In addition to that, you should know that the National Science Board, last May, established a task force to look at undergraduate education and what the Foundation should do from a strategic viewpoint, not just in 1987,

but beyond, in this area; the task force is finishing up momentarily.

There will be some input from that particular group that we will also reflect in the report we are sending up here.

Mr. GREEN. Obviously, to the extent we can strengthen undergraduate education in your area, we might have some impact on the rather dismal picture of the percentage of undergraduate students going on to graduate school.

Mr. BLOCH. Let me just tell you what programs are in 1987. We are continuing the research in predominantly undergraduate institutions. In fact, we are increasing the target for 1987 to about \$47 million from \$44 million in 1986.

The College Science Instrumentation Program which supplies needed instrumentation for laboratories in undergraduate institutions is being increased from \$5.5 million to \$7.5 million.

By the way, that is a leverage program. We are asking for a 50/50 match from industry or States, and in 1986 we exceeded that number. The contribution was 60 cents versus our 50 cents. So that is a program that is being continued.

In the area of support of undergraduate students which is essentially distributed over most of our grants we are supporting about 3600 students and providing about \$8 million worth of support. We expect that to increase in 1987, as it has been increasing in 1985 and 1986.

Then in our special emphasis area we are adding \$13 million for undergraduate institution faculty development, student research and instructional instrumentation. The increases that we have planned for I think are significant increases.

FY 1985 DEFERRAL IN SEE

Mr. GREEN. I guess it was a year ago we had some concern in this Subcommittee at the deferral of some of the funding for science and engineering education, particularly because, both given the dubious constitutional status of the whole deferral mechanism and the timing of aid to educational institutions, it didn't seem to be a great deal we could do about it at the time we held our hearings.

Can we have some assurances that there is not going to be a carry-over of those funds this year?

Mr. BLOCH. Absolutely. You have an absolute assurance there won't be any carry over from 1986 into 1987.

Ms. TOYE. We have already committed and obligated something in excess of \$31 million of that sum which is essentially right on target. I might also mention an accidental fall out and that is that the carry over was not subject to Gramm-Rudman reductions for technical reasons.

BROADENING PARTICIPATION IN SCIENCE AND ENGINEERING

Mr. GREEN. Mr. Stokes.

Mr. STOKES. Thank you.

Mr. Bloch, as you know, minorities—blacks and other minorities—represent a very miniscule number of scientists and engineers. Even though black America is approximately 12 percent of the

total U.S. population, they are about two percent of the scientists and engineers.

In your budget justifications, for the fiscal year 1987 budget, you state that an ongoing goal for NSF is to work for greater participation of minorities in the science and engineering fields. Can you adequately address this problem with the small budget which is set forth here?

Mr. BLOCH. This is a difficult area, as you know. I don't have to tell you. On the other hand, I think the programs that we have put in place are essentially programs that are pointing the way and that are trying to focus on this particular area.

I don't believe that we will succeed until the whole Foundation and all of our activities are participating in this endeavor. That is why we have to focus on it the way we do and why we want to mainstream these programs.

I think only through that particular means and mechanism can we succeed. But you have to start off somewhere. Over the last few years these programs have been started. I think they have had some good effects.

Have they erased the imbalance? No, they have not. That is a concern and I think they need to be continued. I focus on this particular area together with the CEOST committee and we are working very closely together on these particular issues.

Mr. STOKES. Are you getting any type of complementary assistance from the public sector, from the academic institutions and other sources?

Mr. BLOCH. If you mean by "complementary," are they essentially supporting the program? Yes, they are supporting the program. Some institutions more than others.

In fact, CEOST right now has gone through a fairly detailed analysis to see what some of the special programs are that do exist in the various universities and in other government agencies, and we are in the process of publishing the latter findings.

I think it is being printed momentarily.

Mr. MOORE. Yes.

Mr. BLOCH. It will be distributed momentarily. What we want to achieve with that particular report, we want to send it out to all the universities and researchers so they can learn what is available and what universities can do in this particular area.

But you are absolutely right. The Foundation by itself is not going to move that mountain.

Mr. STOKES. That is correct.

Mr. BLOCH. We need to have the support of the universities. Some of the universities are doing very well and others are not. We can share information on programs that work and programs that don't. We hope by putting the report out, we are stimulating the discussion in this area.

We would be glad to make a copy available to you as soon as it is available.

MINORITY RESEARCH CENTER OF EXCELLENCE

Mr. STOKES. I would like a copy of that. Now, I know in fiscal year 1987 you are establishing a minority research centers of excellence program. I think your budget amount is about \$4 million. Can you tell us a little bit about what you are attempting to accomplish here?

Mr. BLOCH. This has been looked at by the National Science Board Committee on Education and Human Resources. It has been recommended that we put this program in place. It is really a take-off on a program that existed in the past which was called the minority resource centers program. So it is a slightly different name, but also slightly different aspect.

What we are trying to do by establishing the centers is put together the right resources to address an area of research and education in institutions to make them areas of excellence. The resource center was a little different.

It reached out into the rest of the community and the rest of the geographic locale. This one is more confined to the university, but equally important.

Mr. STOKES. I have your document entitled "Women and Minorities in Science and Engineering" that was issued January of 1986. I note that your report on page 28 of this report, that blacks and native Americans earning doctoral degrees in science and engineering fields are less likely than whites or Asians to receive financial support from a university, and even if they did, they are more likely to be given teaching rather than research assistantships. Can you tell us about this and why this is a fact?

Mr. BLOCH. No. I can't really speak to why that is a fact. We are observing that fact. I think what we have to do—and that is why we have some programs in existence—is to prime the pump for minorities to participate in the research phase of things and not just in the teaching phase of university life.

Some of what you observe might very well have to do with the universities where the minorities are employed, that these universities don't have the broad research base and, therefore, there is not much research going on there. That could be one explanation.

The other one has to do with preparation for research and that is the reason for some of programs, in order to allow people to get into research and not just teaching.

SALARY GAPS

Mr. STOKES. The same report, Mr. Bloch, also cites the fact that scientists and engineers who are black experience very different labor market conditions from white scientists and engineers. For example, the salaries of black scientists and engineers averaged about \$5,000 or 13 percent less than that for whites.

This gap between the salaries remains even after controlling for field differences. Can you tell us why such a fact would exist with two individuals with the same educational background, and why one by virtue of his race would suffer five percent less in salary or at least 13 percent less in salary?

Mr. BLOCH. Again, I can't authoritatively document why that exists, but I want to make a couple of guesses. A similar situation

in the same report affects also women scientists and engineers. You find that women scientists and engineers earn less than their male counterparts. I think a lot of it is a holdover from prejudices of the past.

I think if you look at industry, industry is very heterogenous. Some of the companies have very progressive programs and attitudes; others do not.

I think out of that difference one gets results that this report describes. I have been fortunate that I have been in an industry and a company in my past that has focused on that particular area and I don't think you will find it there, but there is no doubt that in certain industries and companies you will find this prejudicial difference.

Mr. STOKES. Well, I appreciate the concern that you are expressing regarding what I think is a disturbing national problem. While we, of course, cannot lay the problem at your doorstep, it is encouraging to know there is a concern there and that you are attempting in some measure to address what is really a national problem and a very tragic problem.

It is unfortunate that it is another manifestation of the institutionalization of the problem.

Mr. BLOCH. Can I say one more word on that? You are absolutely right. The Foundation can't rectify the situation single-handedly. What we can do is bring it to the attention of people and that is what this report does.

Secondly, what we also can do is, from an education viewpoint, provide support in the education area and later on in the research area for minorities and women. We are doing that with some of the programs that we just discussed.

Mr. STOKES. I appreciate your concerns. Thank you.

WEDNESDAY, MARCH 12, 1986.

Mr. BOLAND. The committee will come to order.

I want to welcome you here, Mary. You have been here before, a few years ago.

Dr. GOOD. Yes, sir, I have.

Mr. BOLAND. Yesterday, we had a pretty good discussion with the Foundation.

Would you like to give us any comments?

Dr. GOOD. May I?

Mr. BOLAND. Sure. I am delighted to have you.

Dr. GOOD. Thank you very much, sir. I very much appreciate the opportunity to be here.

On behalf of the National Science Board, I would like to submit Dr. Schmitt's testimony for the record, if I may.

Mr. BOLAND. Fine.

[The statement of Mr. Roland W. Schmitt follows:]

STATEMENT OF
DR. ROLAND W. SCHMITT
CHAIRMAN, NATIONAL SCIENCE BOARD
BEFORE THE SUBCOMMITTEE ON HUD-INDEPENDENT AGENCIES
COMMITTEE ON APPROPRIATIONS
U.S. HOUSE OF REPRESENTATIVES
ON THE FISCAL YEAR 1987
NATIONAL SCIENCE FOUNDATION AUTHORIZATION
TUESDAY, MARCH 12, 1986

My primary message is that academic research and education are central to the Nation's economic and defense strength. The international competition of the past decade has been waged, and will continue to be waged, on technological grounds. Our industries that have been surpassed have been surpassed by more advanced technology. Those running neck-and-neck with the competition, such as the semiconductor industry, will only stay that way if they keep pace with foreign technology. And those that are still ahead, such as the computer, aircraft engine, and plastics industry, are ahead because their technology is ahead. It is true that other factors play heavily in the competitive equation. And it is true that we must have a level playing field. But on a level playing field, technology is the distinguishing factor. And when the field is not level, technology is the offsetting factor. If we are to win in international competition, it won't be on the basis of cheaper labor, or cheaper capital, or a favorable exchange rate. It will be on the basis of technology.

From an industrial perspective, by all means the Federal Government must strive to level the playing field. But, just as importantly, it must make the investments in the basic resources needed by industry and defense to win in international competition. Many of the requirements for success lie with actions that only industry can take--streamlining operations, foresight in investment,

commitment to R&D, creativity in marketing, and perhaps above all else, the ability to move quickly. But industry also needs two things that it can't produce on its own:

- ° Scientific and engineering talent
- ° Fundamental scientific and engineering knowledge

These are the raw materials. Only academic science and engineering--the science and engineering base--can produce them.

Examples of the importance of the academic base to industry abound. One need look no further than to the field of electronics, to such university spawned developments as silicon compilers and reduced instruction set computers. Most of chemistry, materials science, solid state physics, biochemistry and computer science are so integral to industrial technology that the distinctions between basic and applied research are becoming even more blurred. And in many areas of engineering research, fundamental research issues--for example, in geometric modeling and analyses, in artificial vision, in motion control, in expert systems--are essential to the design of new products and processes.

Yet, despite the importance of the base to competitiveness, the strength of the U.S. academic research and education base shows signs of wear. The symptoms abound:

- in outdated research equipment
- in obsolete and inadequate research facilities
- in declines over the past two decades in the number of graduates receiving Ph.D.'s in key fields of science and engineering, and in a concomitant increase in the number of foreign national Ph.D.'s

- and in the decline of science and engineering education across the board.

The agenda, not merely for the Federal Government, but for all of us--for industry, for universities, for the states--is large and growing. But it must be met, unless we are willing to cede our technological leadership to others.

That brings me to the National Science Foundation and its budget for FY 1987. The NSF accounts for a very small portion of the federal R&D budget, less than 3%. But in the context of international competitiveness, it is a critical, high leverage component of the federal budget. It is the one component of that budget directly and entirely concerned not with the pursuit of government missions, but with the strength of academic research and education. It may be the smallest component of the federal R&D budget, but from the perspective of competitiveness, it is the most important. This is the context in which the FY 1987 budget proposal should be judged.

The President is proposing an 8% increase for the Foundation and is also proposing real growth in government-wide support for basic research. In the physical sciences and engineering, the increases are even larger. In light of the severe budget constraints that we are operating under, this increase reflects the Administration's continued commitment to the strength of the base. In the context of the budget constraints, the increase is substantial. But in the context of the importance of the science and engineering base to the Nation's competitiveness, and in the context of the growing signs of strain in that base, the increase is also essential.

This year's proposal puts a strong emphasis on four major areas--biotechnology, computational science and engineering, global geosciences, and broadening participation in science and engineering.

Each of these areas significantly affects the health of the science and engineering base. The first three of these strengthen the base at key points of leverage, where major new advances in knowledge are possible, and where the economic effects on important industries are likely to be substantial. The fourth will help build the base by helping to ensure a sufficient supply of high quality scientists and engineers for our future work force.

Each of these emphases crosses disciplinary lines in many ways, and involves many of the Foundation's individual programs. Such cross-disciplinary efforts are important, because it is often at the intersection between old fields that the greatest promise lies.

Each will also foster still more cooperation between universities and industry, and that, too, is part of the solution we are looking for. Both sides benefit when each gains the perspective, experience, and resources of the other.

Thank you for the opportunity to submit this statement.

STATEMENT OF DR. GOOD

Dr. GOOD. Dr. Schmitt apologizes for not being able to be here today.

I would simply like to say a couple of things before we start. I realize that this year in particular is very difficult. We are asking for increased resources in a time when retrenchment is certainly the case nearly everywhere. I understand the problem that the Congress, and this committee in particular, is going to have in dealing with the budget realities for FY 1987.

But it seems there really are two issues that we have to address. One of these is the whole scientific manpower issue, which coming from industry today, I have a real feeling about. And the other is this whole business about what do we do to maintain any kind of decent industrial base.

If I can indulge for about five minutes, I would like to address those two issues, if I might.

SCIENTIFIC MANPOWER

If we are going to be competitive in a global sense, then there are two areas which are going to be really important.

One is this whole concept of manpower—people trained at the cutting edge of technology that industry must have available. We have a problem today in the sense that we have a lot of people in the graduate schools who are not U.S. citizens. I have a particular interest in ceramics research right now, for example, in the company. We are interested in trying to hire some of the best minds in that area.

First of all, there were only 37 Ph.D's granted in that field in the United States last year, and of those over half were non-U.S. citizens. That is a real problem, for two reasons. One is that some of the programs that we do for the government make it very difficult for us to utilize non-U.S. citizens. And, secondly, we have problems just with that number. Thirty-seven Ph.D's simply isn't anywhere near enough to talk about attacking the problem that we have.

The other issue has to do with the universities. I happen to sit on the Board of Rensselaer Polytechnic Institute, and we have made an assessment of the science faculty there. Of the science faculty, over half will retire within the next 10 years. And unless we do something about the number of Ph.D's we are producing and the scientific and engineering areas they represent, I don't see how we will have the base of people to choose from to replace that faculty with the same quality we have presently.

Rensselaer is not unique. If you look at particularly the physical sciences faculties across the country, in 1977 about 45 percent of them were under 40. In 1983, only 26 percent were under 40, and in 1986, I suspect that number has dropped to 20 percent.

We are going to lose, out of the science and engineering faculty in the next 10 years, probably 35 to 40 percent of all the tenured faculty, and there just are not enough people coming out today of the quality that we are going to need to fill those vacancies. So, the issue of manpower I think is extremely important.

The National Science Foundation feeds that pipeline in two ways: through the fellowship programs which we have, and the re-

search programs which support the people that we really need, both in industry and in the academic community—that is, those people who work as research associates on those research programs.

We want people who have hands-on experience and NSF-sponsored research is one way they get it.

IMPACTING THE INDUSTRIAL BASE

I would like to make one comment about the industrial base and the kinds of things that some of the people supported by NSF do. I understand all of you discussed it a little yesterday, but there was a report yesterday in the *Washington Post* which I find absolutely frightening. With respect to high technology products that are going to be available to put into the new programs the country wants to do, the report pointed out the fact that we don't make those things in this country, and we have to buy them elsewhere.

There are two problems. One is that the manufacturing base is leaving, and I have a very strong feeling about that. If you look at the whole concept of a service economy which some of our economists have discussed, I have a problem with that because it does not create any new wealth. There is no way to create new wealth if you have just a service economy. Something has to drive it. We have to be able to maintain a reasonable manufacturing base in this country to compete. If we are not able to do that, I think over the next 20 years we are going to be in serious difficulty across the board.

The country needs the kinds of things that come out of the programs at the NSF—let me just take one example. There is a new concept around which says that it is possible today to design high technology materials. We, in this country, know how to do that better at the moment than anyone else. At the same time that that is true, the Japanese are "eating our lunch" in new materials—developing high quality, high performance materials.

These things are coming into this country. They are materials that are designed to do a particular task better than the material that we had before.

Those suppliers are almost all Japanese. There are Japanese in ceramics, and in some of the engineered plastics. There are Japanese in all of the specialty alloys. The problem with that is that if they control those materials, they control the technology development; and what they are doing is not giving American manufacturers today access to the top of the line of those materials. They are holding them back and putting them in their components, which they then sell you at a very high markup by their technology.

The NSF sponsors the kind of research that builds the data base on which that kind of technology grows. I understand the problems are difficult; I understand that the demands on our resources are very high. But I really do believe that unless we do keep up the momentum in the science and technology and industrial support base in this country, that in 20 years we will have a lot more people who are looking at a much lower standard of living.

In other words, I understand the competition; I understand the problems that you have with monies that have to go to all of our

social programs. But what I see, if we don't keep these things up and don't increase them and don't get the momentum moving, that problem will simply be multiplied by five or ten in 20 years, and all of us will be looking at a much lower standard of living.

So, I would be happy to answer any questions at this time.

SCIENCE EDUCATION

Mr. BOLAND. I am delighted to have you.

You said it today better than I said it yesterday. If we get a change in Administration some time down the road, you are my candidate to head the OSTP.

What was the Foundation's decision on science education? You know, we reap what we sow. And we in the committee have been talking about science education for years. There is no other committee on either side of this Capitol that has really stressed the importance of science education starting at the very lowest of the educational system; no committee one has expressed it more often. Maybe we haven't expressed it eloquently enough. But, in any event, we have constantly been harping on science education, and we don't seem to be getting very far. I am not even sure whether we are getting very far this year, but there will be some questions here.

I would agree with you that if we don't emphasize science education, then we are not going to have the kind of people you say that we need to be sure that colleges, high schools, and other institutions of learning have the people who are in this field.

You say last year there were only 37 Ph.Ds. Half of them are foreigners. I presume that half goes back to their own country, don't they, after it is all over?

Dr. GOOD. No; fortunately, Mr. Chairman, they don't. We would really be in serious difficulty in this country today if it were not possible for us to keep a fairly large number of those Ph.Ds, and somewhere about 75 percent of them—I think, Erich, you may have some figures—actually stay.

Mr. BLOCH. Could I comment on that, because this subject came up because of the question that Mr. Green asked after you left yesterday, Mr. Chairman. He quoted from *Science Indicators*, and I want to explain a little bit better than we could yesterday on the spur of the moment, what the situation is.

Pages 21 and 209 of "Science Indicators—The 1985 Report" are the pertinent pages. Let me turn to page 209 first, which is a table which very clearly states in 1972, of that those foreign Ph.Ds with post-doctoral plans in the field of science, 29% had firm plans to stay in the U.S., and in 1983, 47 percent had plans to remain in the U.S. These are people that are here on temporary visas, non-resident aliens.

Now, yesterday, the number of 23 percent, was mentioned and that comes from a bar chart on page 21. But if you add the right-hand side of the chart which shows employment in the U.S. and that portion of the left-hand side of the graph which shows plans for post-doctoral study in the U.S. (for some reason unknown to me post-docs are not considered employees) then you get to 47.1% that have firm plans to stay in the U.S. I think that clarifies the situa-

tion. The point is 47 percent of the people stay here, and in some fields even more so. For instance, in engineering it is more like 56.3 percent in 1983, a higher number.

The other point I want to make is the total number of people on temporary visas that are studying for Ph.Ds in 1983 was approximately 3,300 people. The count in 1984 is 3,650. So, the point I wanted to make is it is increasing year after year, and also has significantly increased from 1983 to 1984.

I hope that clarifies your question, Mr. Green.

Mr. GREEN. It certainly does, yes.

PRECOLLEGE EDUCATION OF FOREIGN-BORN FACULTY

Mr. BOLAND. Where do they all get their pre-college education? Not here?

Mr. BLOCH. Not here. Mostly not here.

Mr. BOLAND. Isn't that the problem?

Dr. GOOD. The problem is two-fold. One, they don't get their pre-graduate school education here. Secondly, there are problems in terms of the university.

One of the big problems engineering has today is the number of foreign born faculty. It really is a problem in the universities with many of these folks, because they are good people, they are good scientists, but their language skills are not what you would like, particularly to teach freshmen and sophomores. So, there are all of those problems. But many of them come with very good educations, particularly the Far Eastern people, the Asians.

Mr. BOLAND. I think what we are saying is that we are missing the science education below that particular level, and the foreigners apparently are better able to get it in their own countries. And the emphasis, I presume, in those countries is probably greater than it is here.

Is that a fair statement?

Dr. GOOD. I think that is absolutely correct.

The real tragedy is we are not attracting our own bright, young people into the science curriculum. That really is the issue.

Mr. BOLAND. I see.

Lindy?

PRECOLLEGE EDUCATION OF U.S. STUDENTS

Mrs. BOGGS. Mr. Chairman, that was the point that I wanted to emphasize, and why I have been so pleased that the Foundation has each year focused attention upon the lower and lower grades in the school system, recognizing that we have to interest the young people early on.

I have a great deal of contact with teachers in the school system, in the elementary school system, the middle school system, and secondary school system. And, of course, one of the real problems is that we have to educate the teachers, and then get the teachers in to educate the children.

Unless we do that—unless we get the teachers in to the lower grades, the young people who get to high school will not be prepared to take the courses that they want to take to be able to go into college or to compete for some of the scholarships that they

could receive in college. I find more and more young people coming to see me saying, "I would be so pleased to be able to concentrate in the sciences and math, but I don't have the proper credits for it in my middle school years"—or my freshman and sophomore years in high school.

It would appear to me that we have to concentrate on the teachers of the young to make certain that the curriculum at the lower grade levels include the courses that enable the young people to be able to go into the sciences and math as their major in high school, and so that they are eligible to go into the courses in college and perhaps to be able to compete for some of the scholarships.

You will notice that oftentimes the foreign nationals who come here for their graduate work are not from affluent families. They are often from families that are not the least bit affluent.

We have to bring good science and math courses into the schools where the young people who are talented and have an interest will have the opportunity for study and will have the opportunity for scholarship programs.

There is another big problem, and that is that science and math teachers aren't paid sufficiently to attract them into the school system at a lower level. That, of course, is a political question, particularly for the local school boards: Which teachers do you pay more? Which is the most important part of education? Indeed, are science and math more important, and should the teachers be paid at a higher level than the humanities, and so on?

But I think it behooves us to try to work out these problems or else we are going to find our pool of talented Americans smaller and smaller as time goes on.

SCIENCE EDUCATION AT ALL LEVELS

Mr. BOLAND. The National Science Foundation is really about the only agency in the government that handles this particular problem. I don't know any other particular agency that is interested in science education in the grammar or elementary schools and on up that should be targeting more dollars in this area than this Foundation. In a sense, you are almost responsible for the problem.

Mr. BLOCH. I hope we are responsible for the solution, Mr. Chairman, not the problem.

Mr. BOLAND. Well, we look to you for the solution.

Mr. BLOCH. Can I comment on that?

Mr. BOLAND. You can comment, because I think it is a very serious one, as Lindy does, and Mr. Green, and all of us do here.

Mr. BLOCH. I appreciate the focus that this Committee had on education, and it was very helpful to us to focus our programs. I just want to make a couple points.

First of all, education spans a very broad area. It is not only pre-college education; it is not only undergraduate education; it is also graduate education. Our problems are apparent in all of these three areas. It is not just in the pre-college area of education.

I agree that the pre-college area—that is why we are focusing the directorate for science and engineering education on this particular area—is a very neglected area and one that we need to address.

Over the last couple of years, as you know, we have stabilized that directorate. We have added dollars to it, as you know, and so has Congress. And I think the programs that have been put in place—and we can talk about those in more detail as the day progresses—I think are going to bear fruit in the future.

We are also looking right now at undergraduate education. And, as you know, we have some programs in that particular area to address undergraduate teaching and undergraduate instrumentation. That, again, is a very important area.

The last area that we are having a lot of educational involvement in through our research grants is graduate education. The problem that we were focusing on yesterday was essentially the fact that we are not attracting enough people into the science/engineering professions, and especially with the drop in the 22-year-old cadre of people that will get worse rather than better. That is why we have to focus on that.

And also, along with the discussion we had yesterday, we are not attracting enough U.S. citizens into the Ph.D track. What Mary Good said is absolutely right. We have openings today in faculty positions we can't fill, and that situation will get worse as that population gets older.

So, Mr. Chairman, NSF is focusing on the problem. We have put a lot of focus on it. We have put a lot of financial support behind it. And yes, we have prime responsibility for it.

Mr. BOLAND. Bill, do you have questions?

INDUSTRIAL SECTOR RESEARCH

Mr. GREEN. I would just like to return to one item which we discussed a bit yesterday, and that Dr. Good raised again today. That is the suggestion that we have the data base in what NSF does, but it is the Japanese who produce the product. What ought we to be doing so that that data base is utilized by American industry to produce those materials first?

Dr. GOOD. That is a very good question and very pointed from where I sit, as you can appreciate, because the industry really is in the position to hopefully do something with that data base.

One of the problems is that if you look at the record during the Seventies, the industrial sector in the United States, for lots of reasons, did not put back the kind of R&D dollars that are going to be required to make the system go.

But, if you look at what has happened since about 1980, they are trying to get back into the fight. If you look at the numbers, it has increased steadily every year, and it increased even in a couple years early in the eighties. In 1982 and 1983, when there really was a major recession in many of those people's businesses, they cut back lots of people, but they did not cut back in their R&D efforts. So, I think perhaps they have learned from that.

One of the issues that confronts us today is that people believe that it is possible to delay, and frankly that is what they really thought in the early Seventies when a lot of businesses began to close in. There were lots of reasons for diversification. Changes were coming around. We had to figure out how to do things differently. So they thought a lot of that R&D could be delayed.

Well, we are paying for that delay at this moment in time because no one else filled the gap. The same will happen again; if we slow it down at this point, that same catch-up problem will be there again.

The other problem, particularly in the very vital materials area, is it has taken the industry a reasonable amount of time to readjust because we are used to in this country—the steel industry is a good example, or case in point—we are used to being able to make a profit on high-volume, low-margin, high operations.

The types of materials that we are talking about now and the things that were addressed yesterday in that Post article are very different. They are small-volume, highly selective materials needed to do certain jobs. Now they are high-value-added, but the total amount of that material may be very small because you build different materials for special purposes. So, we have to learn how.

The Americans are just going to have to learn how to make a profit out of a large group of materials, all of which may be small volume, but high-value-added. That simply has been a learning experience.

The Japanese started without the handicap, if you like, of having to work in the old scheme of things. They didn't have all of that capital already invested. It is very difficult for a CEO to talk about setting up new capital facilities and small facilities to make six products when he has got millions of dollars tied up in a capital plant that makes one product very efficiently. That has been one of the problems, and that is one of the ways that we sort of got trapped. I think it is beginning to turn, but it is going to take some concerted effort.

Mr. GREEN. Thank you, Mr. Chairman.

ALLOCATING RESEARCH DOLLARS WITHOUT PEER REVIEW

Mr. BOLAND. Thank you very much.

Let's get in for a moment to the peer review process I mentioned yesterday. This Committee, probably more than any other Committee in the Congress, has tried to support the peer review process which we think is terribly important. The review process, as we know it, is being destroyed by end-runs around the process—which ought to give institutions great concern. I think all of you recognize what we are talking about.

Were any of the projects funded without peer review in supplementals? Last year, I think between the FY 1985 supplemental bill and FY 1986 appropriations bills we had about \$190 million worth of projects that went to specific institutions, and those institutions and their projects were not subjected to peer review.

Do you have any in here?

Mr. BLOCH. No. We never had any projects in the past or today that did not go through peer review or were directly mandated by Congress.

If I might, if I can comment further on this particular issue, that has occupied a lot of my time and a lot of the National Science Board's time. As you know, the National Science Board came out with a statement and a report last year. Unfortunately, the effect of it has not been felt. In fact, if anything, during last year a

higher number was allocated outside the review process than the year before.

What is even more disconcerting is the fact that in the past it had to do with facilities—brick and mortar—buildings. Now we are seeing a different kind of trend, and I called attention to it last year and called it a slippery slope. I didn't think we would see it develop as fast as it did, but we are seeing it today.

As you put facilities in place and brick and mortar in place, the next year you have to put in equipment, and the following year after that you have to put in research dollars in order to make the original investment pay.

In 1986, we had allocations where the Congress appropriated not only facility dollars but also research dollars without the use of peer review. Now one could—if one is charitable—make excuses for the facilities aspect because a lot of the universities are in deep trouble with facilities, but one leads to the other, and that is my concern. Allocating research dollars without peer review is much more serious.

The whole system will unravel if we don't put a stop to it, and the Foundation is dedicated, and so is the National Science Board, to doing everything we can for this not to happen. However, there is very little we can do about it, I must say, because it has to do with the self-discipline of the universities themselves, and it has to do with the self-discipline and action that Congress takes.

IMPACT ON PEER REVIEW QUALITY CONTROL

Mr. BOLAND. Some of the projects were funded in fiscal year 1986, in 1985 in the supplemental budget process, and also in the Continuing Resolution. As I have indicated, some \$190 million in direct funding for academic facilities and research were provided by the Congress, and these were provided absent the peer review system.

I take it you and the Board think this is a serious problem?

Mr. BLOCH. I think this is the most serious problem we are facing, because peer review in the past has been not only used to allocate dollars but was also a tool for quality control on research itself, research and education. Without that quality control, I doubt we would be in the forefront of research as we are today.

Mr. BOLAND. Was the National Science Foundation called upon for comment on any of these specific proposals in the last couple of years?

Mr. BLOCH. To the best of my knowledge, we were not called upon.

Mr. BOLAND. Are there any questions or comments in this area?

Dr. GOOD. Only one, Mr. Chairman.

The difficulty is likely to get worse in the next few years because the demand on resources at the universities is very, very high today. Particularly, some of the State universities—Lindy knows very well what the situation is in the State of Louisiana right now—are in financial difficulties, and the universities find themselves in a position where their presidents and their boards will do almost anything to try to get over next year's problems. And that is why you see these things breaking through. If you look at the support that we have provided for them in terms of facilities and

equipment, it has just gone almost to nothing in the last four or five years. So they are just up against the wall.

They cannot get the additional resources—there is nothing to be gotten from the State governments. The State universities are in that problem. Some of the private ones are in even worse difficulties. So, it really is a matter almost of despair in some ways—that is the reason they come through this kind of a proposal.

How to attack that problem, Mr. Chairman, I am not too sure, because it really is true that I think we cannot have a system of science education and science research in the United States which is focused only in 20 institutions. The distribution issue is real and has to be dealt with, so you know those are the two ends of the problem. It is not an easy one.

GEOGRAPHIC AND INSTITUTIONAL DISTRIBUTION

Mr. BOLAND. Can you exercise any leverage in this area, as a result of whatever specific grants you might make to institutions of higher learning?

Mr. BLOCH. Well, as you know, the peer review system allows for a series of criteria. One of them has to do with geographic distribution and institutional distribution. We are exercising that in a significant way. In fact, we just conducted a study within the Foundation to see how our geographic distribution really looks.

I would like to show you the results of that particular study, if I may. It is kind of an interesting one. It brings out many of the points, discussed.

If I could ask you to look at these particular charts that we are introducing into the record. Let me turn to chart number 1. The accusation has been made many a time that only a few States are the beneficiaries of NSF funding. What has been essentially said was that if you take the total NSF R&D dollars and divide it by 50, by the number of states, you come out with a very skewed distribution.

Indeed, if you do that as chart number 1 shows, essentially you can conclude this. You see maybe half a dozen states that are sticking out over the average per state, and then it trails off to almost zero.

I would suggest, Mr. Chairman, that that is a poor way of looking at geographic distribution or any distribution by just dividing it by the number of States.

Let me go to chart number 2, which takes a different approach. It takes the number of R&D dollars and divides it on a per capita by state basis, the number of people in the state. You see that the picture that you saw on the previous chart, where there was a high peak on the left side of the curve, all of a sudden changes, and it broadens itself out, and more states are above the average, close to the average and at the average.

EPSCOR STATES

Let me make one other point on this chart. The black colored states are the EPSCOR states.

These are states the Foundation is focusing on in the past and is focusing on this year and next year that we know are deficient in

scientific and engineering research and scientific and engineering education, and we try to bring these states up to a more acceptable level.

If you go to the next chart, chart number three, this is, again, taking the R&D dollars of the Foundation and dividing them by the academic science and engineering population of each state.

You can't do research in the state if you don't have any scientists or engineers in the state. If you do that, you see again, a smoothing out of the curve, and many more states are participating in a significant way above or at the average.

The EPSCOR states are still standing out, essentially, as not participating, except one. You then look at the last chart which is, essentially, taking an index of high quality proposals over the past few years. You see the results for yourself.

The point I want to make is essentially this. I think just dividing the dollars by 50 is a superficial way of looking at it.

If you look at it on a per capita, or more important, on an academic science and engineering per capita basis, I think we are not doing as badly as some people would say we are.

We are not doing as well as we should, and that is why we have certain programs in place like the EPSCOR programs to bring some of the states to a more acceptable level where they can participate in a vigorous way.

[The information follows:]

NATIONAL SCIENCE FOUNDATION ANALYSIS
GEOGRAPHIC DISTRIBUTION OF AGENCY FUNDING

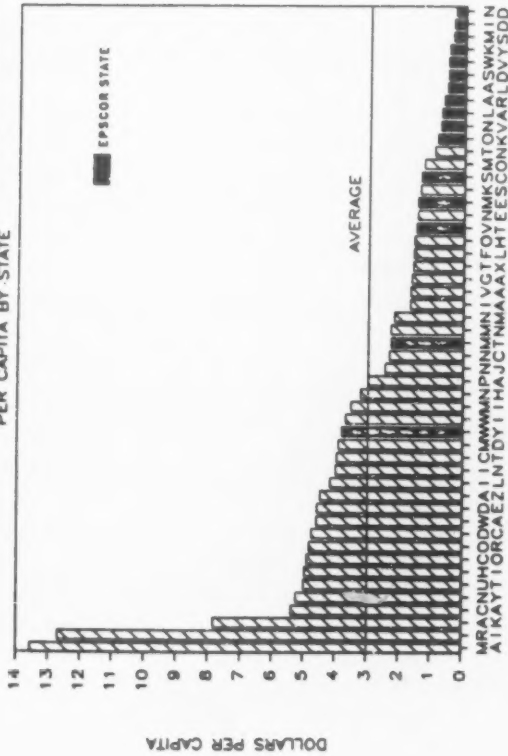
The following charts are all based on the relative distribution of 1983 R & D funds of the National Science Foundation. The measure chosen to distribute these funds differs; the first two are commonly used to measure the relative equity of NSF's funding patterns against some standard other than science. The fourth, and last, is a presentation of the impact of NSF's standard for research excellence on its funding distribution. The third, the number of scientists and engineers, is an attempt at a halfway measure.

The substance of the analysis displayed by Charts 2, 3, and 4 is that when viewed against a number of different, but significant parameters, the distribution of NSF funding is clearly more equitable than Chart 1 would lead one to conclude. The data on Charts 2, 3, and 4 show that almost half of the states exceed or meet the average funding level indicated. Further, in many of those states where funding levels are significantly below the average, NSF is making a concerted effort to assist in the improvement of the scientific and engineering research and education infrastructure through such activities as the Experimental Program to Stimulate Competitive Research and enhanced support levels for undergraduate institutions in both the research and education activities of the Foundation.

PY

NSF R&D \$ TO UNIV. & COLLEGES PER CAPITA BY STATE

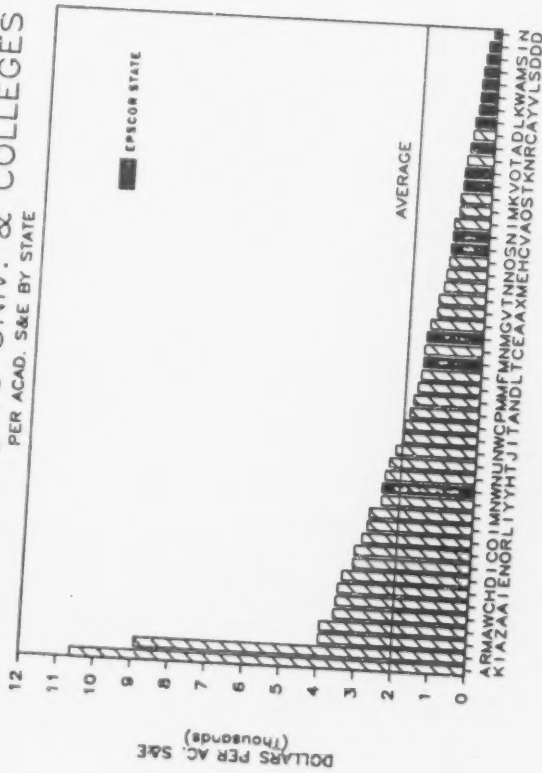
CHART 2 of 4



NSF R&D FUNDING TO UNIVERSITIES
AND COLLEGES PER CAPITA
BY STATE

- o Same NSF funding data divided by each state's population. Plotted in descending order of per capita state funding.
- o The high states are Massachusetts (\$13.56/capita), Rhode Island, Alaska, California, New York, Utah, and Hawaii.
- o States represented by solid bars are the states being assisted through EPSCOR.
- o Twenty-two states exceed or meet the average including such states as Delaware, Arizona, Wyoming, and New Hampshire.

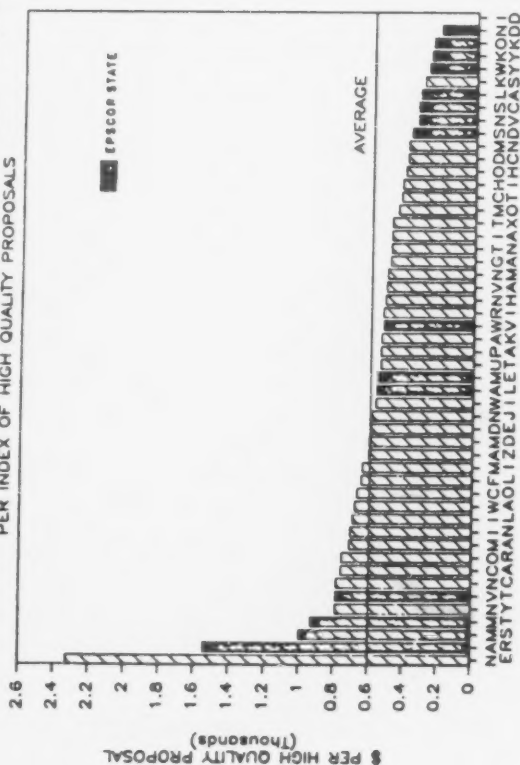
SOURCE: National Science
Foundation Feb. 1986

NSF R&D \$ TO UNIV. & COLLEGES
PER ACAD. S&E BY STATE

NSF R&D \$ TO UNIV. & COLL. BY STATE

PER INDEX OF HIGH QUALITY PROPOSALS

CHART 4 of 4



- o NSF R&D funding per state divided by a sample of high rated proposals from each state in the years 1980, 1981, and 1982.
- o The chart shows that, in general, NSF's allocation of R&D obligations to academic institutions is proportional to the highly rated proposals coming from a state.
- o States represented by solid bars are the states being assisted through EPSCOR.
- o Nineteen states exceed or meet the average including such states as Nebraska, Arkansas, Mississippi, Montana, Florida, and North Carolina.

SOURCE: National Science Foundation Feb/ 1986

THE BRICKS AND MORTAR ISSUE

Mr. BOLAND. Relating that particular effort to the peer review process, let me ask again whether or not the NSF can use any of its leverage so that the peer review process will not be distorted as it is now. For instance, can NSF make specific grants for equipment and facilities?

Mr. BLOCH. We went through yesterday, for instance, and focused very heavily with you on the equipment portion of the National Science Foundation's budget.

It has been increasing over the years, significantly increasing over the years.

Where we have not done very well, because we don't have the wherewithal, is in the facilities area, in the bricks and mortar area.

But there again, we put out a letter, an important notice to all of the universities, allow to come into the Foundation with facilities requests and requirements if it is coupled to a research activity that they are submitting to the Foundation.

By that approach, we can get facilities peer reviewed in the same way as we are reviewing the research itself, and the coupling of the two together assures we are not doing just facilities work for the sake of facilities work.

I should tell you that the dollars that we can put into these particular areas are kind of minimal because of our total budget.

But on the other hand, we have done facilities grants in the past in greenhouses, in some buildings that are required for supercomputer centers, and we will probably do more in the future where we are coupling research and facilities together.

To me, that is one way of assuring one does not go on a different track in building from that of research.

Mr. GREEN. I guess what it may get down to is if you consider this really critical, could you use your leverage as a funding agency by threatening not to fund an institution that runs around the peer review situation?

Mr. BLOCH. That is a very difficult situation. I know you realize that. I am not inclined to do that for obvious reasons.

Because, again, research should stand on its own feet. It should be judged for its value and for what it can do and contribute. Who is to say that in a university that just circumvented the peer review system and got a facility in place, there is not a researcher somewhere in a corner that can make an immense contribution.

I think we would really hurt ourselves in the long run. I think the moral persuasion of the National Science Foundation and the National Science Board is a better weapon.

ON COMBINING DUTIES OF DIRECTOR NSF AND SCIENCE ADVISOR

Mr. BOLAND. Let me ask—at one time the Director of the National Science Foundation was also the science advisor to the President.

That changed some years back. Would you favor the director of NSF being the Science Advisor to the President?

Mr. BLOCH. Heavens, no. Let me explain why I am saying that. The job of the Director of the National Science Foundation, I can assure you, is a full-time job. I think if you split it between that

full-time job and another full-time job, then you won't be satisfied with the results on either side.

Secondly, I also think there would be some inherent conflicts, because after all, the Science Advisor has to overlook the total establishment of the United States Government as it applies to science and research.

I can be a little bit more parochial as Director, and I should be a little more parochial as the Director of the National Science Foundation, so I think you have an inherent conflict there.

Mr. BOLAND. It will be made a lot simpler, because the recommendation of OSTP is to reduce their budget by about 40 percent. OSTP will have nothing to do because it won't have the personnel to do it.

It would appear that the President could get more, and better, advice from the director of the NSF, if he were the science advisor to the President, than OSTP can give with the reduced budget and personnel it faces in fiscal year 1987.

Mr. BLOCH. I can't talk to that particular budget, because I don't know it in great detail, but let me make a few comments.

OSTP, today as it is structured and with the number of people that it has, does a large number of different things. Not all of it is advising the President, obviously. Not all of it is just overlooking the budgetary and programmatic aspects of the various agencies.

If they have to live with a smaller budget, then I think they have to drop some of the things that they are doing which are not their prime responsibility.

So, I would still think it would be a very worthwhile organization.

Mr. BOLAND. In any event, I guess we will have to limp along with the present structure, then, since you have refused to take the job.

Mr. BLOCH. I didn't know it was offered.

SCIENCE AND ENGINEERING EDUCATION

Mr. BOLAND. We will get into the budget. We will turn to NSF-15. I will be quoting the pages, and you may turn to them if you wish, but we will be racing through this over the next few minutes.

It appears that science and engineering education "brings up the rear" in your priorities. It enjoys the smallest increase among the programmatic areas with the exception of the U.S. Antarctic program, and that is explainable because the Antarctic program no longer is paying the cost of the ice breaker function. So, actually, science education does enjoy the smallest increase, and increase of about 2.3 percent. Why is that?

Mr. BOLAND. Why do we have problems in getting science education more money?

1986 budget the allocation was \$50 million, roughly speaking, with a carry-over of \$32 million from the previous year, to make a total of \$82 million.

What you see, essentially, in the 1987 budget is, first of all, a no carry-over assumption. As we said yesterday, there won't be a carry-over from 1986 into 1987. So, the dollars that had to be allocated to this particular budget really was one that went from \$50

million to \$82 million, and then to the \$89 million figure that you see here.

So, the increase as part of the total Foundation's budget and base plan area was an increase of \$32 million, and then \$9 million more on top of it.

By the way, this allocation was done with great forethought, number one, but it also caused a lot of difficulties, because of the total allocation that we had available to ourselves that we had to distribute between the various directorates.

We went from \$50 million to \$89 million, roughly speaking, in the budget itself. So, you see hidden in here, because of this carry-over from one year to the next, there really is a much bigger increase than the \$2 million that you see at the bottom line here.

Mr. GREEN. If you look at it over a two-year or three-year period, that really isn't true, because we had appropriated something like \$116 or \$120.

Then you had the deferral, which is what got you, so really it has been running level at about \$80-million.

Mr. BLOCH. Don't forget, Mr. Green—and we discussed this last year at length—we had a problem spending the money and we made that particular point in the 1985 hearings and that is why we carried this over.

We had to rebuild the directorate from scratch. It didn't exist a few years ago. We had a new assistant director who is no longer that new, but was new at that particular time.

We had new people in the directorate. We had new programs in the directorate. The point I made last year was, essentially, we can only go so fast.

And I think what has been done so far is stabilizing that program, all of these ups and downs we have seen in the past were not helpful, and that is why we are where we are.

But behind that, I think, is the story of the last couple of years of rebuilding this particular directorate and putting the plans and programs in place that will pay off in the future.

PRIORITY SETTING FOR SEE IN OMB

Mr. BOLAND. As you have indicated, we discussed this last year, and it was the thinking on this side of the table the problem was not with spending the money. The problem was with OMB.

You did indicate that you could not spend any additional funding effectively beyond the carry-over of \$31.45 million which became available in 1986.

That was the judgment of OMB, was it, and really not your judgment?

Mr. BLOCH. Again, we had these discussions last year, if I remember correctly.

Mr. BOLAND. We did.

Mr. BLOCH. I will never hide behind OMB. It was my judgment last year that we should postpone some of the dollars into the following year, and I stay with that.

Since you are bringing up OMB, let me say something. That is exactly what I indicated before. The mark in OMB when we start-

ed the budget process for 1987 was \$50 million. That is where we started from.

So, OMB, by looking at this particular program, by discussing it with us, found it essential to agree with us at the \$89 million level.

Is it a compromise? Yes, it is a compromise level, just like all the other numbers in the budget. We asked for a lot more in total NSF funding from OMB than we received. But we started off for 1987 with a \$50 million mark for SEE, so you see a lot of movement there by OMB.

Mr. BOLAND. What did you request of OMB for fiscal year 1987?

Mr. BLOCH. I think it was \$92 million. Let me go through that with you in more detail, because again, it is somewhat more complicated.

We went into OMB with a request that talked about the base, and then talked about the additional thrusts.

I look at this as one total program, but nevertheless divided up in that particular way. Essentially, in the base area of the budget we went in and asked \$92 million for SEE, and we got \$89 million.

In addition to that, we went, essentially, with four major thrusts. One of the thrusts has to do with developing potential and broadening the participation where, again, SEE has a very major role. We asked for \$20 million for SEE in that thrust, so that would bring the SEE total request up to \$112 million.

Mr. BOLAND. So, you requested \$112 million of OMB for fiscal year 1987 in the science and engineering education program. Can you effectively spend that level in 1987?

Mr. BLOCH. In 1987 we can effectively spend a level that includes the \$89 million that we have, plus some of the special thrust area that we also have.

We didn't get the full thrust area, but we got——

Ms. TOYE. Essentially, we got the base figure and the authority to act on any of the initiatives.

Mr. BOLAND. I presume if you requested \$112 million in 1987, you can effectively spend it, is that correct? Is that a fair assumption?

Mr. BLOCH. We can spend it effectively in all areas, yes. We asked for more in many of the areas, and what applies to SEE applies to the other directorates, also. Yes, we could.

On the other hand, I must say again what I said yesterday, that the budget is a balancing act, a compromise at best, always, and you are trying to, essentially, move the operation forward, in unison: the whole Foundation.

You are trying to move the various disciplines forward. You are trying to move education forward at the same time you are trying to move all forward, so it is essentially a compromise.

I think taking one directorate out of context will give us serious problems.

FY 1987 SEE OBLIGATIONS TO DATE

Mr. BOLAND. Let me ask you, of the \$87 million available in fiscal year 1986 before Gramm-Rudman, how much have you obligated, to date?

Ms. TOYE. The commitments and obligations through February in science education were \$30.1 million. I saw this morning the sum-

mary for today, and I believe there were an additional \$7 million in there, so we are running at about, at this point, the order of \$37 million.

I can give you that precise listing, if you want, for the record.

Mr. BOLAND. Okay.

[The information follows:]

Science and Engineering Education Commitments and Obligations as of March 10, 1986

	<i>Commitments and obligations</i>
Research career development	\$389,490
Materials development, research and informal science education	16,187,262
Teacher preparation and enhancement	11,175,956
Studies and program assessment	2,327,697
College science instrumentation	1,995,729
Subtotal	32,036,134
Uncommitted funds ¹	52,619,541
Total availability	84,655,675

¹ Approximately \$27.0 million will be obligated in the third and fourth quarters of FY 1986 for Fellowships. This is the normal schedule for the annual award of Fellowships.

REORGANIZATION PLANS

Mr. BOLAND. Let me ask you a couple of questions about reorganization. We have been offered a number of reorganizations by the NSF over the years, and sometimes it appears you are having a reorganization just for the sake of reorganization. There must be a dozen or more programs that have floated in and out of the Scientific, Technological, and International Affairs Directorate (STIA).

Do you have any plans to totally eliminate the STIA Directorate?

Mr. BLOCH. I have no plans at this time to totally eliminate STIA. Let me tell you how I look at STIA.

First of all, there are a number of major programs in there, like the international programs, which you mentioned, and the science resources analysis area that is responsible for the *Science Indicators* report that we talked about yesterday.

And then I look at the STIA as an incubation directorate where one starts small programs off like we did with the women's programs and minority programs until they reach a certain level, allow them to develop, and then distribute them to the rest of the Foundation.

We need a place where one can start something that is somewhat out of the mainstream but that later on becomes very important to the mainstream.

So, I have no plans right now to look at STIA and dis-establish it. I have some other organization plans, however.

FY 1986 AND FY 1987 SUPPORT FOR FTE'S

Mr. BOLAND. On NSF-11, you indicate that your personnel level will remain at the current authorized amount of 1,174 full-time equivalents.

Actually, as I understand it, both your 1986 and your 1987 budgets do not have sufficient resources to support 1,174 FTEs; is that correct?

Mr. BLOCH. No, that is not quite correct.

First of all, let me say one thing. We are below that number today in a significant way.

Mr. BOLAND. What is your current on-board total of permanent positions?

Ms. TOYE. Full time permanent position total is 1,009, I believe. Our total employment right now is about 1,155.

Mr. BOLAND. Is that current FTE?

Ms. TOYE. The current FTE utilization straight line to the end of the year—if we were to hire no one and lose no one the rest of the year—would be about 1,103 plus about 14 consultants; that is, about 1,117 would be our straight line.

Mr. BLOCH. Let me explain. The Foundation over the last few years has come down significantly in the number of people, permanent employees, as well as in the number of FTEs.

As we go into 1987, with all of the uncertainties of 1987, we are essentially playing that one very closely. We are monitoring it on a daily—on a monthly basis, so that we don't get into a situation where we overstaff in 1986 and then have to, essentially, RIF people in 1987.

By the way, we did exactly the same thing as we moved from 1984 into 1985, and from 1985 into 1986; we kept the input valve closed in order to get us to the appropriate level.

That causes some distortions, you should know, because who leaves the Foundation is kind of a random process, and then you have to go back and ask yourself where the unbalances are in skills and personnel.

We have been in the process of rebalancing, and that is why we went through selective hiring, but we want to assure you we have that in focus.

We are not going to go into 1987 out of kilter with the requirements or with the capabilities of the 1987 budget, and we are playing it in a conservative way.

IMPACT OF BUDGET ON WORKFORCE

Mr. BOLAND. Let me say again, the justification listed 1,174 FTEs; we understand the amount of money requested for 1986 and 1987 cannot support that number of FTEs.

Ms. TOYE. Let me discriminate. First of all, in this area the budget processing is hampered by having vestiges of about four personnel accounting systems in it. In 1986, we cannot reach a total utilization rate of 1,174 because we started the year well under that level. In order to bring the rate to that level we would have to go out and hire a number of people that then would put us substantially over that ceiling going into 1986.

That would be irresponsible. That is something that we have read in the paper that other agencies have gotten caught up with. We clearly are not going to do that.

We have a detailed analysis which I will be happy to submit for the record and to meet with your staff subsequently if you wish. We have done a careful analysis that shows we will end this year with something on the order of 1,150 FTE's and be placed in position with about 1,160 going into next year. This is part of a two-year readjustment of work force that we

have been engaged in. So I will be glad to give this detail for the record.

Mr. BOLAND. You may supply that for the record.
[The information follows:]

FULL-TIME EQUIVALENTS

Currently, we are running at about 1115 FTE's including consultants, at an annualized cost of about \$45,660,000. The current FTE rate and associated personnel funds are well within our current plan as we were coming out of a hiring freeze when the uncertainty related to G-R-H slowed recruiting down. We are now beginning to staff-up, particularly in lower graded positions, and expect some attrition at the higher levels (GS-14 equivalent and above) due to the possible change in retirements benefits, among other things.

Our 1987 request includes approximately \$46,440,000 available for personnel compensation. At our current rate, we have \$780,000 for additional staff resources:

1987 Compensation.....	\$46,440,000
1986 Annualized cost	45,660,000
	780,000

Since the annualized rate funds 1115 FTE's. Assume, for example, the following scenario:

Between now and September 30:

	Amount	FTE
Attrite 15 GS-14 and above.....	(\$915,000)	(15)
Hire:		
45 Clericals.....	810,000	45
3 GS-14.....	135,000	3
6 GS-13.....	240,000	6
10 GS-12.....	330,000	10
Net effect.....	600,000	49

We can summarize the effects of this scenario on our 1987 budget as follows:

	Amount	FTE
1986:		
Annualized cost.....	\$45,660,000	1115
Scenario effect.....	600,000	49
Total.....	46,260,000	1164
1987 Request Availability	46,440,000	1174

Although this is just as example, it is possible for the NSF to fund very close to the 1174 ceiling in 1987 and still be within the requested PC&B levels.

Mr. BLOCH. I want to assure you again we are not going to do something on a peak basis that later on we are regretting in 1987. We are blending the years together the best we can to keep both years in perspective and, by the way, at the same time our average rate per year, per person, is coming down.

Mr. BOLAND. You can understand our concern. If you indicate 1174, our concern is whether or not you have sufficient funds to really meet that obligation and paying for 1174 FTEs.

Ms. TOYE. In the budget year, very definitely, sir, we can.

Mr. BOLAND. Let's turn to mathematical and physical sciences.

Dr. GOOD. Mr. Chairman, I am going to have to leave. I really appreciate the opportunity for having been here today and I apologize for having to leave early.

Mr. BOLAND. We are always delighted to have you, Mary. How long are you going to be on the Board?

Dr. GOOD. My term is up in May of this year.

Mr. BOLAND. Not much I can do about that.

DATA ON INVOLVEMENT OF WOMEN AND MINORITIES

Mrs. BOGGS. Mr. Chairman, I would like, while Mary is still here, to compliment Mr. Bloch on the great improvement of women and minorities within the Foundation, and on the magnificent report that has been submitted to us on Women and Minorities in Science and Engineering. This is something Mary has been interested in for a long number of years.

I am really extraordinarily grateful to all of you for the report and for the findings of the report. In past testimony NSF has indicated they were working to obtain fact and figures on the actual participation of women in the grants and fellowships of the National Science Foundation.

Could you tell us what progress has been made to collect this data, and if information is now available, what are the actual statistics?

Mr. BLOCH. First of all, we made a lot of progress in that particular area by attaching a form that asks for exactly that information of every grantee. Now that was implemented and we have a copy of that form here which we can put in the record or give to you, Mrs. Boggs.

Mrs. BOGGS. Mr. Chairman, may we put it in the record?

[The information follows:]

INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS

INSTRUCTIONS:

Only ONE copy of this form is to be submitted with your proposal. Please attach it on top of the cover page of the copy of your proposal that bears the original signatures. Leave the back of the page blank and do not include this form with any of the other copies of your proposal, as this may compromise the confidentiality of the information. Submission of this form is required before processing will be initiated.

	Principal Investigator/ Project Director	First Additional PI/PD	Second Additional PI/PD	Third Additional PI/PD	Fourth Additional PI/PD
Please check the appropriate answers to each question for all principal investigator(s)/project director(s) listed on the cover page, using the same order in which they were listed there:					
1. Is this person:					
Female	☐	☐	☐	☐	☐
Male	☐	☐	☐	☐	☐
2. Which one of these categories* best describes this person's ethnic/racial status? (If more than one category applies, use the category that most closely reflects the person's recognition in the community.)					
American Indian or Alaskan Native	☐	☐	☐	☐	☐
Asian or Pacific Islander	☐	☐	☐	☐	☐
Black, not of Hispanic Origin	☐	☐	☐	☐	☐
Hispanic	☐	☐	☐	☐	☐
White, not of Hispanic Origin	☐	☐	☐	☐	☐
3. Does this person have a handicap which limits a major life activity?					
Yes	☐	☐	☐	☐	☐
No	☐	☐	☐	☐	☐
Check here if this person does not wish to provide some or all of the above information					
	☐	☐	☐	☐	☐
* AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliation or community recognition. ASIAN OR PACIFIC ISLANDER: A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands and Samoa. BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa. HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race. WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.					

WHY THIS INFORMATION IS BEING REQUESTED:

The National Science Foundation has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity or handicap of the proposed principal investigators and co-principal investigators. To gather the information needed for this important task, NSF requires that a single copy of this form be submitted with each proposal; however, submission of the requested information is not mandatory and is not a precondition of award. Any individual not wishing to submit the information should check the box provided for this purpose.

Information from this form will be retained by NSF as an integral part of its Privacy Act Records System, NSF-29, "Proposal and Award Information." These are confidential files accessible only to NSF personnel, and will be treated as confidential to the extent permitted by law. Data submitted will be used in accordance with criteria established by the National Science Board for the selection of projects, published in NSF 83-57, "Grants for Scientific and Engineering Research."

Mr. BLOCH. That form is essentially the basis for our data. Now, you should understand that this only has been implemented in the last few months so we do not have a full year's results. In the meantime the number of people that are answering the form is increasing; this is a voluntary form so you don't have to fill it out. We have seen an increase in the number of people that are answering these questions. I think that will continue as we move down the road so in the future I am convinced we will have better data than we even have today.

WOMEN INVESTIGATORS AND RESEARCH

Mrs. BOGGS. How successful has NSF been in integrating women investigators into the regular research programs?

Mr. BLOCH. As you know, our awards to women have been on the increase from year to year. In 1985, the support to women principal investigators is something on the order of ten percent.

The year before it was about eight percent in terms of the proposals. In terms of the awards, it has gone to about 8.2 percent and that is an increase from 7.5 percent the year before.

It is slow progress, but it is progress.

Mrs. BOGGS. Thank you, Mr. Bloch. Thank you, Mary.

MATHEMATICAL AND PHYSICAL SCIENCES

Mr. BOLAND. Thank you very much, Mary. Have a nice trip.

We will turn to the Mathematical and Physical Science where you are requesting \$449,250,000 for 1987. The justification indicates that the current plan is \$409,970,000, but that does not reflect sequestration. What is the actual 1986 level as based on Gramm-Rudman?

Ms. TOYE. I have—in fact, I can submit for the record the post Gramm-Rudman figures. After the reprogramming approved by this committee, MPS has \$392,683,216.

[The information follows:]

SUMMARY BUDGET INFORMATION
BY ACTIVITY AND SUBACTIVITY
GRAMM-RUDMAN-HOLLINGS IMPACT

ACTIVITY	CURRENT PLAN NOA FY 1986	REVISED 1/ CURRENT PLAN	DIFFERENCE
MATHEMATICAL AND PHYSICAL SCIENCES			
Mathematical Sciences	\$51,740,000	\$51,740,000	80
Computer Research	40,170,000	38,231,552	(1,938,448)
Physics	118,630,000	112,905,379	(5,724,621)
Chemistry	89,780,000	85,447,567	(4,332,433)
Materials Research	109,650,000	104,358,718	(5,291,282)
TOTAL	\$409,970,000	\$392,683,216	(\$17,286,784)
ENGINEERING			
Engineering Science in Chemical, Biochemical, and Thermal Engineering	29,180,000	27,771,887	(1,408,113)
Engineering Science in Mechanics, Structures, and Materials Engineering	23,700,000	22,556,330	(1,143,670)
Engineering Science in Electrical, Communications, and Systems Engineering	25,700,000	24,459,818	(1,240,182)
Science Base Development in Design, Manufacturing, and Computer Engineering	18,790,000	17,797,611	(902,389)
Fundamental Research in Emerging and Critical Engineering Systems	36,195,000	34,448,370	(1,746,630)
Cross-Disciplinary Research	29,000,000	27,600,573	(1,399,427)
TOTAL	\$162,475,000	\$154,634,590	(\$7,840,410)
BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES			
Molecular Biosciences	61,930,000	58,941,500	(2,988,500)
Cellular Biosciences	52,130,000	49,614,409	(2,515,591)
Biotic Systems and Resources	61,020,000	58,075,413	(2,944,587)
Behavioral and Neural Sciences	45,690,000	43,485,179	(2,204,821)
Social and Economic Science	30,040,000	28,590,387	(1,449,613)
Information Science and Technology	9,260,000	8,813,148	(446,852)
TOTAL	\$260,070,000	\$247,520,035	(\$12,549,965)
ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES			
Astronomical Sciences	84,220,000	80,155,871	(4,064,129)
Atmospheric Sciences	96,780,000	92,109,774	(4,670,226)
Earth Sciences	48,940,000	46,578,346	(2,361,654)
Ocean Sciences	124,030,000	119,436,984	(4,593,016)
Arctic Research	8,520,000	8,108,858	(411,142)
Total	\$362,490,000	\$346,389,834	(\$16,100,166)
SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS			
Industrial Science and Technological Innovation	15,760,000	14,999,484	(760,516)
International Cooperative Scientific Activities	10,840,000	10,316,904	(523,096)
Policy Research Analysis	1,940,000	1,846,383	(93,617)
Science Resources Studies	3,940,000	3,749,871	(190,129)
Research Initiation and Improvement	6,990,000	6,990,000	0
Total	\$39,470,000	\$37,902,642	(\$1,567,358)

1/ Revised Current Plan reflects Gramm-Rudman-Hollings reductions, plus
Reprogrammings approved by the Committee affecting Mathematical Sciences,
(NPS), Ocean Drilling Program (AAEO), Visiting Professorships for Women and
Research Improvement in Minority Institutions (STIA), and Program Development

SUMMARY BUDGET INFORMATION
BY ACTIVITY AND SUBACTIVITY
GRAMM-RUDMAN-HOLLINGS IMPACT
(Continued)

ACTIVITY	CURRENT PLAN WOA FY 1986	REVISED 1/ CURRENT PLAN	DIFFERENCE
Advanced Scientific Computing	\$45,230,000	\$43,047,368	(\$2,182,632)
Program Development and Management	72,500,000	71,882,500	(617,500)
Total, Research and Related Activities	\$1,352,205,000	\$1,294,060,185	(\$58,144,815)
U.S. ANTARCTIC PROGRAM			
U.S. Antarctic Research Program	11,500,000	11,005,500	(494,500)
Operations Support	103,600,000	99,145,200	(4,454,800)
Total	\$115,100,000	\$110,150,700	(\$4,949,300)
SCIENCE AND ENGINEERING EDUCATION			
Research Career Development	27,300,000	26,126,100	(1,173,900)
Materials Development, Research, and Informal Science Education	9,250,000	8,852,250	(397,750)
Teacher Preparation and Enhancement	11,500,000	11,005,500	(494,500)
Studies and Program Assessment	2,000,000	1,914,000	(86,000)
College Science Instrumentation	5,500,000	5,263,500	(236,500)
Total	\$55,550,000	\$53,161,350	(\$2,388,650)
Special Foreign Currency Program	1,000,000	957,000	(43,000)
TOTAL, NATIONAL SCIENCE FOUNDATION	\$1,523,855,000	\$1,458,329,235	(\$65,525,765)

1/ Revised Current Plan reflects Gramm-Rudman-Hollings reductions, plus
Reprogrammings approved by the Committee affecting Mathematical Sciences,
(HPS), Ocean Drilling Program (AAEO), Visiting Professorships for Women and
Research Improvement in Minority Institutions (SFIA), and Program Development
and Management.

PROPOSED REPROGRAMMING

Mr. BOLAND. Your letter of February 13 to me requested that after Gramm-Rudman cuts were applied, you wanted to reprogram sufficient funds to keep the mathematical sciences sub-activity at the 1986 current level plan of \$51,740,000.

Ms. TOYE. That is correct.

MATHEMATICS PROTECTION

Mr. BOLAND. The letter suggested that the mathematical sciences area was one of the three highest priorities in the Foundation, and in view of that, I wonder why in the original current plan restructuring which was necessitated by a Congressional decrease in 1986, this activity was tapped for a 5.4 percent reduction within the Mathematical and Physical Sciences Directorate. Why was this particular Directorate tapped more heavily than, let's say, physics?

Dr. NICHOLSON. The decision to protect mathematics in the Gramm-Rudman reductions was made by Mr. Bloch and it reflects a reprogramming of the entire Agency, not just within this part of the agency's budget.

It comes about from the fact that the National Research Council report showed that some very serious structural problems have developed in mathematics. Mathematics, of course, underpins all of the sciences and engineering.

It is not important just to physics and chemistry, but it is important to everything in science and engineering. So trying to redress the problems that developed in mathematics was considered a priority of the Agency and the National Science Board.

The reprogramming protection was a judgment made by Mr. Bloch.

Mr. BOLAND. Look at the table on page MPS-3. If you look at the percentage cut, before Gramm-Rudman the mathematical sciences subactivity was cut by 5.4 percent; in physics there was a 3.8 percent reduction:

Mr. BLOCH. You have got to look at the 1985 level because this particular area, mathematics, got the biggest increase going from 1985 to 1986. We could not sustain that increase in light of Congressional action and, therefore, we had to take some of the increase away.

But they still got a significant increase over 1985. So you have to really come from the 1985 to the request level for 1986 and then to the current plan.

PHASE-OUT OF LOWER PRIORITY ACTIVITIES IN MPS

Mr. BOLAND. On MPS-4, your 1987 budget is highlighted by sub-activities. There is a greater emphasis being placed on mathematical sciences which enjoys a 15.6 percent increase above the current plan for 1986. I am recalling your statement, which indicates you will be phasing down or terminating activities of lower priority or lesser promise.

In this Directorate for 1987, what activities have been phased out or terminated?

Dr. NICHOLSON. There are several kinds. In the materials area there are two materials research labs that are being phased out. There are presently 14 such laboratories in the country and we are phasing out two of them. In the computer area we will probably phase out one or two of the coordinated experimental research centers.

In the other areas such as chemistry and mathematics, most of the grants go to individual investigators and each year there is a significant turnover in the proposals and investigators that are supported that way, so reductions in those areas really amount to raising the quality cut-off where the funding decisions are made, so the turnover there is among individual investigators.

COMPUTER SCIENCE RESEARCH

Mr. BOLAND. All right. On MPS-II-1, computer research, you are requesting \$44,400,000 for 1987. On the next page we see the break-out of the changes between the original 1986 and the current plan, however, again without the application of the additional reductions of Gramm-Rudman.

But I did notice you changed emphasis fairly significantly between the original request and the current plan. For example, theoretical computer science is showing an 8.4 percent increase, even though the entire area of computer research is in for \$1,560,000 decrease. Why is that, and who made the determination to apply the reductions in the manner?

Dr. NICHOLSON. For theoretical computer science, the difference is the difference that occurred between the time the 1986 budget was presented and the time of the current plan. In that period of time, the greatest number of proposals of high quality that we received were in this area of theoretical computer science.

It is an area where MPS has a special responsibility because the other mission agencies that do support research in computer science tend to support more applied aspects of it. So the role of MPS is particularly acute in the theoretical area.

It is the area that provides all of the intellectual underpinning for this kind of activity. So it was the judgment of our staff at the time of the current plan, based on the number of proposals that we had in hand and the programs in the other mission agencies that support this area, that it was appropriate to shift the money in the way you see.

COORDINATED EXPERIMENTAL RESEARCH

Mr. BOLAND. Now, the legend on II-3 and 4 indicates that you are de-emphasizing the coordinated experimental research program and reducing the number of experimental computer research facilities. How long have these facilities been funded? How successful do you think they have been?

Dr. NICHOLSON. We started this activity in 1981 in an effort to do two things. One, to broaden the base of computer science in universities in the country. It was a very distorted situation at that time.

Four universities had the bulk of the resources for conducting research in computer science. And also it had evolved so that the activity had become too theoretical in the judgment of experts in this

area. This program was designed both to broaden the base in universities in the country and also to make sure that experimental activities could be done as well as theoretical activities in university research.

We started the program in 1981 and made four grants in that year. The grants were intended to provide long-term support for facilities and equipment so each of them is a 5-year grant. So it started in 1981, with four grants.

In the years since we have made four or five additional grants each year, so at present that are 22 of these facilities distributed around the country. The four grants that were made in 1981—since they are 5-year grants—are expiring this year.

At the end of this year, if we do not make any additional grants, the country will have 18 such facilities. Those four institutions, plus an additional ten, have submitted proposals to us to renew those four or establish some new ones, and those proposals are under review right now.

It is my guess we will probably fund three or four. The budget that we have in the current plan in 1986 would allow us to fund three or four of these facilities.

Mr. BOLAND. I think you indicate that in the justifications.

Dr. NICHOLSON. Everyone I know and have talked to and listened to believes the program has been an enormous success. It is a little like good news, bad news. It has been so successful it has created an increased demand for funds for independent investigators, because it has allowed these universities to bring in new faculty, and they submit proposals to us to get that research supported. That is why you see a little shift in the balance in the budget as we go from 1986 to 1987 between this very successful program and the individual investigator kind of support.

CORNELL ELECTRON STORAGE RING

Mr. BOLAND. Under the physics subactivity you describe the stretchout of the upgrade work on the Cornell electron storage ring. On the top of page MPS-III-3 you indicate that because of the overall budget reductions, this particular facility will receive \$9.3 million instead of \$12 million as was originally planned in 1986. The 1987 proposal assumes about \$12.3 million, and you indicate that this will imply a stretchout of funding with a 1 year delay in completion beyond the original fiscal year 1988 date.

Last year in response to my question, on page 176 of the hearings, Dr. Bardon indicated two additional years after 1986 would be required to complete the funding for this project. That would have been fiscal year 1987 and 1988. Is that correct?

Dr. NICHOLSON. That is correct.

Mr. BOLAND. Now, you indicate that you are going to spend \$9.3 million instead of \$12 million in 1986 on the upgrade of this facility, but are you really going to spend the \$9.3 million after the application of the Gramm-Rudman-Hollings? How much is needed to complete the CESR upgrade if you spend \$9.3 million in 1986?

Dr. NICHOLSON. If we spend the \$9.3 million in 1986, and \$12.3 million in 1987, as in the request that is before you, we estimate it would require an additional \$5.6 million in 1988 to complete the

project. That would be a total cost of \$37.6 million, an increase of one-and-a-half million dollars due to the stretchout by 1 year.

IMPACT OF GRAMM-RUDMAN ON CESR

Mr. BOLAND. The question is, are you really going to spend the \$9.3 million after the Gramm-Rudman-Hollings?

Dr. NICHOLSON. The \$9.3 million, as you know, is before the Gramm-Rudman reduction and this program, like the rest, except for mathematics, is not exempt from it. Therefore, the number that we project now would be, I think, \$8.9 million, which is the \$9.3 million less 4.3 percent.

That would increase the figure I just gave you in 1988 by about four-tenths of a million, to \$6 million.

Mr. BOLAND. Now, the justification indicates that the stretchout is going to cost an additional million and a half; is that fair?

Dr. NICHOLSON. Yes.

Mr. BOLAND. The upgrade of this project demonstrates the kind of problems that we had with the very long base line array. That project had to be reduced in fiscal year 1985, and in 1986, and in 1987 to roughly a \$9 million-a-year level, which, of course, stretches out the funding; but with the Gramm-Rudman-Hollings facing us each year for the next 4 or 5 years, it does not seem to make much sense to fund all of these projects and have every one of them stretched out and costing much more money in the end.

What is your reaction to that?

Dr. NICHOLSON. Well, I agree with you that it is a very serious problem.

Mr. BOLAND. What about dropping some of them? Then we won't have to worry too much about them.

Dr. NICHOLSON. Well, this particular facility is a very important one. There are only four facilities in the United States for conducting research in high energy particle physics, and of the four, this is the only one that is integrated into a university environment where graduate students can actually get degrees working in that department in this area.

Accelerator physics and the design of these machines is a very important activity and yet we train hardly any people in this country in this area because the other three facilities are located at national laboratories.

So we regard this as a very important facility for that reason, because it is part of a university environment. It has been an enormously successful facility in terms of the physics that has been done with it. The original construction came in on time and under budget.

It runs at about 6,000 hours a year. That is really an incredibly successful, efficient operation in that sense, so we regard it as a very important facility.

What we do with the budget problems is something we are looking into right now. I have encouraged the people at Cornell to try to get additional funding from the university in the case that we have a reduction.

We also have an operating budget there and in the worse case we would consider shutting down the operation for some of the year

and moving money to construction to complete the upgrade. If we do not complete the upgrade, the physics that one can do there will have been undermined, and the facility will not be useful for high energy physics.

UPGRADES AND NEW CONSTRUCTION

Mr. BOLAND. I think you make a good case for the Cornell facility, but the question was with reference to all of the facilities. If you start to stretch them out, they are all going to cost more money in the end.

Will you provide for the record all projects currently being upgraded or under construction with the use of any Foundation dollars, when those projects were initiated, what their original cost estimates were, what their original complete dates were, what the current cost estimates are, and what the current completion dates are.

[The information follows:]

CURRENT NSF CONSTRUCTION AND UPGRADE PROJECTS

[In millions of dollars]

	Start date	Original cost estimate	Original completion date	Current cost estimate ¹	Current completion date
Construction:					
Very long baseline array	4/84	\$61.5	1990	\$81.5	1994
National superconducting Cyclotron Laboratory					
Michigan State Phase II	1980	30.0	12/84	² 34.7	1988
Upgrades:					
National Center for Atmospheric Research Advanced Vector Computer	1985	20.0	7/86	³ 29.35	11/86
Indiana University Cooler Facility	4/83	8.9	12/86	⁴ 10.2	9/87
Cornell Electron Storage Ring [CESR]	2/85	36.0	1/88	39.4	1/89

¹ Current Year Dollars.

² Funding: DOE \$16.4 M; NSF \$18.3 M.

³ Includes \$24.5 M in hardware costs and \$4.85 M in interest payments on lease-purchase arrangements.

⁴ Funding: State of Indiana \$3.9 M; NSF \$6.3 M.

Mr. BLOCH. Can I just comment on your general point?

FACILITIES

Mr. BOLAND. Sure.

Mr. BLOCH. We will provide that information that you just asked for. I just want to make a point on facilities in general.

These are new facilities that we are talking about or upgrades in the case that we just discussed. They have to be considered within the priority of our total research budget. We have looked at all facilities in light of Gramm-Rudman, in light of the reduction in 1986, and we found these facilities to be of very high priority. Therefore, we are assuming the additional cost that it takes to stretch them out rather than discontinuing them.

I think the same applies to 1987, which becomes a very difficult year. If Gramm-Rudman comes in with large reductions like the question that was asked yesterday, then again we have to look at the total priority.

It is not at all clear that we still would not continue some of these new capabilities and sacrifice some of the existing ones. That might be a much better trade off.

The point I want to make is, one just should not look at one particular facility but look at them in total to see what the requirements are of the Foundation and of the science community and then make the decision on a priority basis.

MATERIALS RESEARCH GROUPS

Mr. BOLAND. On materials research, MPS-V-1, I note you are requesting \$117,350,000. On MPS-V-2, under the materials research subactivity, I notice that the program element for the materials research groups increases by 29 percent from the original budget request, even in the face of a significant 5.2 percent reduction overall.

On the next page, we see that the \$4.8 million carried in the current plan is going to almost double in 1987 to \$8.8 million. Last year you indicated, and it is reflected on page 179 of the hearings, that you were going to fund about seven of these at \$500,000 a piece.

Have those numbers changed, and why have you increased the activity in 1986 by 29 percent when the overall funds for this area, as in all areas, have been reduced. It appears as if you are placing greater emphasis on materials research groups than materials research labs. Why is that?

Dr. NICHOLSON. That is correct; we are. This is an activity that is inherently more interdisciplinary in character than the other activities in MPS. That is because to do research on materials, and the kind of things that Dr. Good referred to earlier in her statements, often requires a collaboration between scientists and engineers with different skills.

For example, if one wants to look at the surface properties of materials, you need people who are expert in surface physics, but you also need people who understand chemistry and people who understand metallurgy.

So this is an activity that is inherently interdisciplinary. That is why these material research laboratories exist.

They provide the base and core of support in order to make it possible to do collaborative research, involving chemists, physicists and the like.

The materials research laboratories have been very successful over the years, enormously so, I would say, but they operate on a scale that only a small number of universities in this country can accommodate, because not that many universities have expertise in all these different areas.

So one cannot imagine a materials research laboratory at every university. As a result of that, a gap really had developed in how we supported this area.

We had the small individual investigator awards and we had the large materials research laboratories and nothing inbetween. The materials research groups, as we call them, were designed to bridge that gap, to provide support for collaborations at an intermediate level.

The program was started in 1985 where we made five awards for \$2.5 million. That year we had 20 proposals and made five grants.

This year we received 30 proposals, which are under review right now, a 50 percent increase in the number of proposals. It was our judgment at the time we submitted the current plan that the quality of those proposals was such that we really wanted to fund at least four or five additional groups in 1986, and therefore, we requested the reprogramming that you see in the current plan.

It is really as a result of the proposals that we got between the time the budget was submitted and the time of the current plan.

MATERIALS RESEARCH LABS

Mr. BOLAND. That is a good answer, incidentally.

Let me ask about the material research labs. Last year the indication was that number would be 14, with a possibility of increasing to 15. The hearings also indicate later in the discussion that two materials research labs might be terminated to provide adequate support for those remaining.

In the justifications on MPS-V-3, you indicate that two materials research labs are being phased out. Does that still leave the number at 14 or below 14?

Dr. NICHOLSON. It leaves the number at 14 right now. The procedure we are using to phase out these two laboratories is to do it over a three-year period of time. They are not being phased out for cause, so to speak, because there is something wrong with the quality of the research.

They are being phased out simply because they do not meet the requirement for broad scope and highly interactive kinds of research and, therefore, to minimize the disruption and effect on graduate students, we are phasing those two laboratories out over a three-year period of time.

So there are 14 right now. The two that are being phased out will be completed by the end of 1987, so that at the end of 1987 there would be 12.

WISCONSIN SYNCHROTRON RADIATION CENTER

Mr. BOLAND. Let's turn to the Wisconsin Synchrotron Radiation Center for a minute. This was discussed last year at length in the hearings.

At that time the indication was that you had \$3.5 million in the 1986 budget for the Wisconsin Synchrotron Radiation Center, and that you had under review the entire question of whether NSF was going to continue funding the construction of what is known as the Aladdin Storage Ring at the Center.

In June you wrote the Committee indicating you had decided to stop construction of the upgrade because the project was now going to cost an additional \$30 million to complete. What happened to the \$3.5 million? That isn't quite clear.

Dr. NICHOLSON. The \$3.5 million is part of the source of the funds we put in the materials research groups activity we were just talking about. The decision not to continue the construction on the so-called Aladdin Ring at Wisconsin did save us about, I guess, eight-tenths of a million dollars.

The present budget is \$2.11 million right now, and that is to operate the Tantalus Ring and to do some research on trying to improve the Aladdin Ring operating characteristics, without any additional construction.

I might say, the people at Wisconsin have been very successful in that regard, in fact, and they have a proposal that is pending now to NSF that requests decommissioning this so-called Tantalus Ring that is the original one there, and switching operation to the Aladdin Ring in its present form, which is substantially under the original design goals.

That is why we terminated the construction, but nevertheless Aladdin operates at useful levels—so we are considering that proposal right now. But the answer to your question is some of that money is the source of the reprogramming that we requested for the materials research groups.

Mr. BOLAND. On the same page, you indicate that you will reduce support of the Wisconsin Radiation Center by \$800,000. That is correct, is it not?

Dr. NICHOLSON. Right.

Mr. BOLAND. I know that you have worked with the staff on these issues, but you don't indicate what are you reducing it from and what you are reducing to.

Dr. NICHOLSON. Well, it had been running at almost \$3 million, \$2.9 million, as I recall, plus the construction. That was to operate this—you have to remember, there are two facilities there right now, an old ring called Tantalus and the new one for which the construction was completed, largely unsuccessfully, about a year ago.

So there are two facilities there. The Tantalus Ring is a user facility to provide this form of radiation for users and we have been supporting that operation for a number of years.

Mr. BOLAND. What impact does the \$800,000 reduction have on the center?

Dr. NICHOLSON. It has no impact right now because of the fact that we are still operating the Tantalus Ring. It is still providing some funds to try to improve the performance characteristics of the Aladdin Ring which, as I said, they have actually been very successful at doing.

ALADDIN

Mr. BLOCH. Mr. Chairman, if I could comment on that. If you remember in last year's hearings we were at the point where we were faced with an increasing budget to complete Aladdin. In fact, at the last point before we cancelled the project, it would have cost us an additional, if I remember correctly, \$30 million.

Mr. NICHOLSON. We estimated \$30 million, yes.

Mr. BLOCH. That is why we cancelled it, because it went out of sight, and what you are seeing now essentially is the project and capabilities at the point at which it has been stopped, but still in a usable form.

So we have made a major change in the Wisconsin Synchrotron facility.

Mr. BOLAND. Will you detail that a little more for the record?

Dr. NICHOLSON. Certainly.
[The information follows:]

THE SYNCHROTRON RADIATION CENTER AT THE UNIVERSITY OF WISCONSIN, MADISON, WI

The Synchrotron Radiation Center [SRC] at the University of Wisconsin, Madison, WI, has submitted a proposal to NSF to phase out its storage ring (Tantalus) and to begin operations on the larger 1 GeV ring (formerly called Aladdin) as is. This proposal is currently pending. A site visit by an outside team took place on March 17 and 18, 1986. A recommendation is being prepared for consideration by the National Science Board at its meeting on May 16 and 16, 1986.

Since plans for the major \$30M upgrade of the 1 GeV ring were cancelled, remarkable improvement in beam current has been made, particularly in the time frame November 1985 thru March 1986. Maximum currents of 140 mA at 800 MeV can now be obtained, i.e., about six times higher than maximum currents obtainable a year ago. This was achieved in a cost effective manner by installing ion-cleaning electrodes in the ring where possible, improving the vacuum of the ring, and applying radio frequency voltages in the range of ion oscillation frequencies to the electrodes. Beam lifetimes are now on the order of a few hours. Further improvements in beam current and beam lifetime are expected.

Six beamlines at the 1 GeV ring are already operational. Experiments are being carried out. Eleven additional beam lines are planned for implementation by 1986-87. Tantalus is scheduled for decommissioning later this year.

There remains a significant national scientific and engineering need for this facility.

Even though the original design goals (i.e., 1A at 750 MeV as proposed in 1976, or 500 mA at 1 GeV as modified in 1977 when the original award was made) have still not been met, a number of critical experiments can now be carried out on this facility.

The number of ports and the necessary floor space not available elsewhere, allow flexibility and growth in the development of special beamlines.

There are important research topics in this field which require the larger allotments of research time that are uniquely made available at this facility.

This facility can play a unique role in the development of insertion devices, in view of the four long straight sections of this 1 GeV ring.

ENGINEERING

Mr. BOLAND. Let's turn to the Engineering Directorate where you are requesting \$185,470,000. This directorate has been increased substantially when compared with other directorates in fiscal year 1987. Why?

Dr. SUH. When I came to the Foundation in 1984, I estimated the magnitude of research support needed by the engineering research community to be substantially larger than our budget.

Therefore, we discussed the matter within NSF. The director decided that the engineering budget needed to be increased so that we could reach the required level of budget in a few years. I think it is quite appropriate that we do get a larger increase so we can reach a higher level of budget and thus deal with engineering problems adequately.

Mr. BOLAND. On pages ENG-5 and 6, the overall increases are described for 1987. You touched on the heavy emphasis in engineering research centers, described in more detail on ENG-VI-1, 2, 3 and 4. The funding we provided in 1985 which totalled \$10 million created the first six engineering research centers; is that correct?

Dr. SUH. Yes, sir.

1986 PLANS FOR ERC'S

Mr. BOLAND. If I understand it correctly you plan to increase that six by an additional five in 1986?

Dr. SUH. Yes, sir.

Mr. BOLAND. Also, the reduction from the original request of \$25 million to \$23 million, and a further reduction of \$1.2 million under Gramm-Rudman-Hollings leaves you with about \$21.8 million in 1986. How will that affect the funding of the additional five centers this year?

Dr. SUH. Out of 102 proposals we received in 1986, we selected about a dozen for site visits. Out of the dozen, we selected about seven for final consideration. We decided to award the first four centers, more or less, the entire amount needed to operate effectively. For the fifth and last one we reduced their budget request substantially by negotiating with them. However, they can still achieve the goals they established for their centers. The fifth center is getting a substantial cut because we do not have sufficient funds to support the center at the full requested amount.

Mr. BOLAND. In 1986, how much are you budgeting for each center, on an average?

Dr. SUH. The largest grant will be about \$2 million a year. The first two centers will receive \$2 million a year, the third center will be receiving around \$1.4, and the fourth and fifth centers will receive \$1.25 million each.

That is, the first four centers will be receiving the amount they requested. The fifth center requested support exceeding \$3 million a year, but they will be receiving \$1.25 million, which is a substantial reduction. We think we can help them in other ways so they can still achieve their goals.

1987 PLANS FOR ERC'S

Mr. BOLAND. What about the \$12 million increase targetted for 1987? What is the average you are budgeting?

Dr. SUH. We think that after we provide the increases that we need to provide to the centers in place by then, we will have only sufficient funds left for about four centers. It will depend on the quality of proposals we receive and the budget available. However, we feel we should be able to establish somewhere between three to four centers in 1987.

Mr. BOLAND. The total for 1987 for engineering research centers is \$35 million. I understand you are planning to support 15 centers from that total.

Dr. SUH. Yes.

Mr. BOLAND. Will four of those centers, the new ones, be funded only for a partial year?

Dr. SUH. Well, as of now we think that is not a good policy. Later on we will have to come up with the rest of the money. Starting in 1986, we will fully fund the center for the entire year rather than the way we did in the first year. In 1985, we provided nine months funding and then the rest in 1986. We decided not to continue that practice.

So we will try to fund for the entire year. What that means is that instead of setting up four centers, we may end up setting up

only three, but I think that is a better way to operate rather than setting up large numbers of marginal centers that cannot fulfill the ultimate goal of the center.

Mr. BOLAND. Taking a look at the engineering directorate, and specifically at the cross-disciplinary program where you are placing a strong emphasis, let's assume for a minute that the 1987 Gramm-Rudman-Hollings reduction is 7.5 percent.

That would reduce your request by about \$2.8 million. This year in the reprogramming based on the Gramm-Rudman-Hollings cut for 1986, you did not attach any higher priority to these particular centers.

Given a further reduction for 1987, would you plan to take the same approach?

Dr. SUH. Yes. If indeed a 7.5 percent reduction takes effect, our thinking is that we should not start any new centers in 1987. We would maintain the ones we have started by the end of fiscal year 1986. Even then we will have to provide a slight increase for the ERC program to continue the momentum we have built up in establishing these 11 centers.

We don't think we will have enough funds to start new centers and have an effective program. The ERC program will come to a halt as far as starting new centers in 1987.

LONGEVITY OF ERC'S

Mr. BOLAND. How long are you going to fund these centers?

Dr. SUH. According to the recommendation we received from the National Academy of Engineering Committee that studied the matter for us, their thinking was that we should indefinitely continue to fund these centers, provided that they perform the functions that were originally designed for these centers.

What that means is that we will be evaluating their performance once every three years and decide whether or not we should continue supporting them purely based on the quality of the research they do. If their quality is up to our expectations, we hope to continue the support of the centers on an indefinite basis.

Mr. BOLAND. Last year you indicated that you were going to fund these centers for about five years.

Dr. SUH. Five years was only the original grant period. We haven't stated explicitly that we will not continue supporting them after five years have lapsed.

However, our hope is that as these centers build up an industrial support base, the need for NSF funding will diminish in the years to come. That is our hope. But as far as maintaining the minimum base support for these centers, I think it is essential because industrial support tends to demand very short term research. The idea behind establishing the ERCs is to conduct research in very basic areas, which means that industrial firms cannot always justify supporting it alone without the involvement and support of the National Science Foundation.

Indeed, much of the basic research NSF supports would not normally be supported by industrial firms. I think it is very important that we continue supporting ERCs by providing them with a mini-

mum base and at the same time let the ERCs go out and raise industrial support to do more applied research that they need to do.

Mr. BOLAND. How much would minimum base funding be?

Dr. SUH. The maximum second-year grant size for two of the 1985 ERC's is somewhere around \$3 million a year. The minimum is around \$1.5 million.

Mr. BOLAND. On ENG-VI-4 the table outlines the funds for 1985, 1986, and 1987. If one takes a look at the \$15 million for the six centers in fiscal year 1987, and multiplies that by an additional nine centers as those come on line, it appears that there is a commitment here of between \$160 and \$170 million over the next five years; is that correct?

Dr. SUH. Yes. We need a substantial increase if indeed everything we have planned for these centers is to be achieved.

NSF COMMITMENT TO ERC'S

Mr. BOLAND. I think you agreed last year you do not look upon this as an entitlement.

Mr. BLOCH. Absolutely not. Let me say something about the centers and about engineering in general.

First of all, it is not an entitlement. These are peer reviewed centers. We had over 100 proposals this year. There are only five of them we are going to fund.

The centers are being reviewed on a continuous basis. One center is reviewed against another one and against absolute standards to make sure they perform and, by the way, the performance depends on many factors.

We have put a high emphasis on the involvement of undergraduate students in these centers to start them off on a research track in order to make them understand what research is all about, plus they have to show the commitment from private sources and so forth.

And the continuation of the centers will very clearly depend on how well they perform. I should also say on total engineering questions, engineering has gotten a large increase over the last couple of years.

On the other hand, it is only about 14 percent of the total Science Foundation in total dollars. So it has come from a very small base with large increases.

Mr. BOLAND. There may not be an entitlement, but you are committing the Foundation to a multi-year funding commitment.

Dr. SUH. We believe that in order to be able to make use of the opportunities provided in engineering in a number of emerging technologies, significant changes must be made. We think this is a good program to enhance our international competitiveness, and significant resources ought to be applied so that the kind of research that requires multi-disciplinary inputs, and people with various, different expertise can join forces together and create new kinds of technologies and new frontiers.

Generation of new engineering technologies, processes, and systems, is a very important element in these ERC's. Therefore, although the absolute resource required to support these centers

sounds like a substantial amount, I think it can be justified very easily.

Mr. BLOCH. I want to say one other thing on that. You have to give universities a long term commitment they can depend on, provided they perform. To put a center like that in place is a large commitment of space, of facilities in general, of administrative support, and of people to the centers.

For one year no university is capable of putting it in place so you have to show them a horizon that is reasonably long, but the understanding is that they must perform if they are going to get increases. If they are going to be continued, it will depend on their performance, but you can't fund them just for one year because it is a big involvement and big commitment by the universities themselves.

Dr. SUH. Mr. Chairman, if I may add one more item. The success of the ERC program can be seen by the responses we have received from industrial firms and State Governments. The NSF awarded only \$10 million last year but the additional sum the centers raised from these other sources to date is \$13 million.

This program has been in place only for nine months and we feel that the support they will derive from industry will continue to increase as they start producing useful results. As that happens, I think we will end up having a very substantial infrastructure in areas where only a large team of this sort can produce significant results.

Dr. NICHOLSON. Mr. Chairman, could I just make a technical clarification?

Awards like these, and the ones I talked about, the ERCs, while we call them five year awards, the commitment to the university is always subject to available funds. We can and may sometimes have to reduce those funds and, in fact, in the case of the Gramm-Rudman-Hollings reduction this year, Mr. Bloch sent out a notice to all universities informing them that we may reduce commitments in these awards by up to ten percent. So they are subject to available funds always.

IMPACT OF GRAMM/RUDMAN ON LONG-TERM COMMITMENTS

Mr. BOLAND. Because of Gramm-Rudman-Hollings, are you having difficulty getting universities into this program, because they see the possibility of no funding in the next year?

What you say is true. The problem is that these are outlays which are going to be impacted by Gramm-Rudman in the out-years. I would think it would present a problem to you.

I can understand why a university might not want to start a program that is funded for one year, putting some of their own money in and not getting any particular assurance it will be funded in the future.

Mr. BLOCH. I haven't seen anybody turn an award for research down because of fears of Gramm-Rudman. On the other hand, you should know there is a lot of concern in the universities of the impact of not only Gramm-Rudman, but what 1987 or 1988 will bring.

A lot of them—there was a conference a couple of weeks ago at the National Academy of Science where we discussed with the universities and with industry the outlook of funding and the effect on them. A lot of the universities are looking thoroughly at their organization and at their own capability and at their own faculty with the idea of having to retrench if these restrained budgets come through.

It is a great concern to the universities and it is a great concern to us, but we hope we can take action to minimize the impact; but there will be an impact.

INDUSTRY/UNIVERSITY COOPERATIVE RESEARCH

Mr. BOLAND. Under the University Cooperative Research Centers, you indicated to us last year that these centers are also funded over a five-year period, and that you expect to establish two or three new centers in 1986. Were those new centers established?

Dr. SUH. Yes, sir. By October of 1986, we expect to have 40 centers in operation. Seven of these centers are now self-sustaining.

That means that they will be operating without any NSF support, with their own funds obtained from industrial and State support. We are in the process of evaluating new ideas that are coming in from the community, and based on this evaluation we may be establishing additional centers.

The reason we can forecast how many centers we can establish in this particular program is that we initially provide them with a planning grant. A number of institutions receive a very small amount of money for planning purposes.

Once the planning is completed, then we choose the promising ones for support and establish new centers.

Mr. BOLAND. Let me ask, these centers are not being funded in 1987, or are they?

Dr. SUH. There are two sub-elements in the Industry/University Cooperative Research Program.

Mr. BOLAND. I am looking at the table. You had \$3 million in 1986, and no request in 1987 for the industry/university cooperative research projects. Also, you had \$3 million in 1986, and a request for \$3 million in 1987 for the industry/university cooperative research centers.

I take it that you are going to utilize the \$3 million for these centers in 1987; is that correct?

Dr. SUH. That is correct.

Mr. BOLAND. Do you think we can agree upon an automatic funding cut for these centers so that we can go to the floor with a Bill that we can get by, and that the President will sign?

How about an automatic cut-off, or even a limitation in the Bill, which says that a center shall not be funded for more than five years, after which time it must be self-sustaining. The universities would like that, would they? Obviously, they would.

Mr. BLOCH. I gather some universities would like it. I think the universities—

Mr. BOLAND. Are any of them self-sustaining now?

Dr. SUH. The IUC centers have to be self-sustaining after five years because NSF support is gradually withdrawn during this period.

Mr. BOLAND. How many are self-sustaining now?

Dr. SUH. Seven out of 40 are self-sustaining. Not only that. The amount of money IUC centers are raising this year is \$26 million.

We are putting only \$3 million in so that is almost nine-to-one leveraging, and I think that really says something about how effective the program has been.

Mr. BOLAND. Have any of these centers been funded beyond the five years?

Dr. SUH. No. None of the IUC centers have been funded beyond the five years.

BIOLOGICAL BEHAVIORAL AND SOCIAL SCIENCES

Mr. BOLAND. Let's turn to the Biological and Social Sciences Directorate, where you are requesting \$282,410,000 in 1987.

On page BBS-3, the justifications indicate that in 1986, owing to the Congressional reductions and other realignments, you plan to take a reduction of \$2.75 million in the planned \$6 million increase for research related to biotechnology. Again, it is difficult to tell what the amounts are for biotechnology when we don't know what the \$6 million is added to or taken from.

Does this directorate support the biggest chunk of the biotechnology thrust?

Dr. KINGSBURY. Yes, it does. The National Science Foundation in fiscal year 1985 invested approximately \$81 million in biotechnology across three directorates. About 80 percent of that money was invested in the directorate for biological, behavioral and social sciences and the remaining amounts were in the chemistry division, in mathematical, and physical sciences, and in two different divisions in the engineering directorate.

INFORMATION SCIENCE AND TECHNOLOGY

Mr. BOLAND. On BBS-VI-1, looking at Information Science and Technology subactivity, you are requesting \$11,910,000. In last year's hearings, the indication was that in 1985, of the \$8.9 million made available, \$2 million was set aside for a special automation effort at the direction of this committee. I assume you know that effort was made in connection with the Committee's interest in automation and robotics on the space station.

Now, does that program continue in 1986 with the \$9.2 million? Describe to us how you are going to go ahead with this space station automation robotics research, and what application it would have for NASA.

Dr. KINGSBURY. Well, yes. That activity began as we promised. The awards were made in different research areas related to robotics.

I am not able to give you specific grant titles or a specific listing as to how that will directly relate to the space station.

I do not have that information available, but I can get it and provide it.

[The information follows:]

AUTOMATION RESEARCH IN INFORMATION SCIENCE AND TECHNOLOGY

Information Science and Technology invests in basic research relevant to automation, automated and intelligent systems, and to human interfaces to such systems.

In FY 1985, 99 proposals were reviewed which were relevant to these topics, and 24 were supported for a .25 success rate. A total of \$2 million was allocated and granted. (Examples of projects supported are listed below.)

Projects were supported through the Information Science and Information Technology programs. As these programs' activities continue to develop, we expect stronger support for robotics-related research. Because the work is very basic and only just underway, we have not yet really pushed toward applications.

EXAMPLES OF PROJECTS SUPPORTED IN FY 1985

Arbib, University of Massachusetts, "Distributed Control and Scheduling for Robots"

Hachtel and Leightner, University of Colorado, "Research on Topological Design Tools for Structured Logic Arrays"

Hopcroft and Wang, Cornell University, "Research in Representing Physical Objects"

Bhanu and Henderson, University of Utah, "Computer Aided Geometric Design Based Computer Vision"

Grossberg, Boston University, "Adaptive Sensory Motor Planning by Humans and Machines"

Hoffman, University of California, Irvine, "Recognition of Objects Using Information from Visual Images"

Mr. BOLAND. Have any of your people had conversations with NASA?

Dr. KINGSBURY. Yes.

Mr. BLOCH. Let me just mention this is a broader program than just what you see in BBS. It is a \$6 million program in the Foundation and MPS, engineering, BBS are participating in it.

ROBOTICS AND COOPERATION WITH DOD

Mr. GREEN. Mr. Chairman, may I ask a question?

Are there other cooperative activities going on with DOD or with the private sector in this area?

Mr. BLOCH. In this area of robotics?

Mr. GREEN. Yes.

Mr. BLOCH. Yes, there are many things going on. There is a robotics engineering research center out on the West Coast which will have industry involvement in it.

Dr. SUH. The automation in the robotics type of effort is spreading in many areas, but as far as the Congress-mandated-programmings, we are concentrating on automation and a system integration program. We have a couple million dollars in it, plus an ERC that focuses on that same area.

Last year we sent about half a dozen ERC proposals to the Air Force to determine whether or not they can fund some of these areas. I visited NASA last year to talk to management there to see whether or not they were going to cooperate with us to establish some of these activities in robotics and other areas.

So we are continuing the discussion and I must say that so far we haven't succeeded in really establishing the center, but I hope we can accomplish that some time in the near future.

Dr. KINGSBURY. And there is coordination within the Foundation, as well

1985 AUTOMATION INITIATIVE

Mr. BOLAND. How much of the substantial increase of 1987 is devoted to the automation initiative that was originally carried at \$2 million in 1985?

Dr. KINGSBURY. There will be a very small incremental increase specifically directed at that. The bulk of the increase in information science is going to be directed toward the need for new instrumentation related to the information science activity.

One of the things that this program has never done is provide instrumentation for the investigators because the program was sufficiently small that even though it was a very computer based activity, we never really provided a partner. We felt that was a crying need and we should step in and attempt to do that.

So a large percent of this percentage increase is going to be directed in that area.

ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES

Mr. BOLAND. We turn to the Astronomical, Atmospheric, Earth, and Ocean Sciences Directorate where you are requesting \$383,210,000 in 1987. That is \$20.6 million above the current plan of \$362.5 million. After Gramm-Rudman is applied to the current plan, your request is \$36.1 million above the 1986 level.

We are going to take a look at how Gramm-Rudman affects some of these programs under this directorate. This may be a good time to ask you how your 1986 budget, after you have applied Gramm-Rudman, dovetails with your 1987 request.

Dr. MERRELL. It dovetails with the 1987 request in that we protected ocean drilling from the Gramm-Rudman-Hollings reduction in 1986 and the ocean drilling program is protected in the 1987 request.

The Gramm-Rudman reduction cut across-the-board. We made our estimates for the 1987 budget based on a different process which came up with a different percentage.

It is not the same at all.

Mr. BOLAND. Your 1987 request was made before the sequestration took effect; is that correct?

Dr. MERRELL. Yes, sir.

ASTRONOMY

Mr. BOLAND. Well, turn to the astronomical science sub-activity on page AAEO-I-1 and take a look at the 1987 request. You are requesting \$85 million. That compares to a current plan of \$84,224,000 and after Gramm-Rudman-Hollings to a level of \$80,598,000. Now under the program elements of this sub-activity, we fund astronomy centers and various astronomy capital improvements. I am wondering how it is that you can take these reductions under Gramm-Rudman with the existing contracts you have with the various centers. Will you, for the record, run through this for the Committee and tell us what you are doing to absorb an \$8 million reduction from your 1986 request.

You may do that for the record.

[The information follows:]

ASTRONOMICAL SCIENCES REDUCTIONS

The total reduction for the Astronomical Sciences subactivity from the FY 1986 Request level to the post Gramm-Rudman-Hollings level is \$8.51 million. Of this, \$2.50 million was required by Congressional action on the construction of the Very Long Baseline Array, \$1.95 million from the distribution of unspecified reductions in the FY 1986 appropriation, and \$4.06 million from distribution of the Gramm-Rudman-Hollings sequestration. The cumulative effect of these reductions from the request level is as follows:

Astronomy Project Support: Reduction of 20 to 25 awards from planned number, eliminating support for 25 to 30 senior scientists, 15 to 20 graduate students, and 10 to 15 post-doctoral scientists. Acquisition of computers for universities reduced. Support for a long wavelength interferometer not renewed. Studies in all scientific areas reduced and studies of new techniques for polishing large mirrors not undertaken.

National Astronomy and Ionosphere Center: Deferral of new pulsar instrumentation and of some renovation and maintenance activities, hiring freeze affecting present vacancies, reductions in travel, supplies, communications, and services. Christmas bonus (a strong tradition in Puerto Rico) cut by half.

National Optical Astronomy Observatories: Slow down in technology development efforts, including deferral of mirror casting experiment, staff reduction of about 30 (7 percent of total staff) through attrition and unfilled vacancies, deferral of computing hardware and reduction of central services.

National Radio Astronomy Observatory: Reduction in research equipment, track maintenance, travel, and services, staff reduction of about 23 (7 percent of total staff) through attrition and RIFs. Reduction in Very Long Baseline Array construction required deferral of nearly all long lead/bulk purchase items for antennas, of purchase of maser clocks and other electronics.

REDUCTIONS AT KITT PEAK AND SAC PEAK

Mr. BOLAND. Turn to page AAEO-I-7. The National Optical Astronomy Observatories are being reduced in 1986 to \$23.8 million and by Gramm-Rudman-Hollings an additional \$1 million. Are any of these reductions being applied to the solar facilities at Kitt Peak and Sacramento Peak which is carried under the NSO line item?

Dr. MERRELL. Yes. Reductions are being applied there.

Mr. BOLAND. The reason I asked that question is that on March 12 of last year I received a letter from NSF indicating the National Optical Astronomy Observatory had completed a review of the Sacramento Peak Observatory in New Mexico to make a determination whether, on the basis of budget priorities, the Sacramento Peak Observatory should be closed. It was the recommendation, as I understand it, to close Sacramento Peak.

However, apparently the Board of Directors of the Association of Research in Astronomy overruled that recommendation and decided that it would be preferable to reduce activities at all telescope locations including the Kitt Peak National Observatory and the Cerro Tololo Interamerican Observatory in order to keep Sac Peak open.

I think this is important. That letter was based on the assumption that \$24 million would be available for 1986. But that level, after the Congressional reduction and after the Gramm-Rudman-Hollings impact, is now only \$22.7 million.

What we have here is a situation where it seems almost impossible you can adequately continue to keep all of these facilities open. What about that?

Dr. MERRELL. We feel we can keep them all open. I personally visited Sacramento Peak and looked at the level of effort. We have determined that at this point we can keep them all working.

Mr. BOLAND. At that level?

Dr. MERRELL. They are not working as well as we would like for them to work. I am not saying they are at the optimum level.

IMPACT OF REDUCTIONS ON EFFICIENCY OF FACILITIES

Mr. BOLAND. What is the sense of them working if they are not going to work as well as you would like to have them work? What about the efficiency of the observatories?

Dr. MERRELL. They are efficient. We have explored every way that we could that would increase efficiency. We have automated to the point where observers can go up there by themselves.

We have less technical help, but because of the automation the astronomers are able to work. I think that at this point we have responded very well on that.

You cannot continue to respond forever. That is for sure, but right now we are responding very well.

I think that the observatories are very efficient places right now.

Mr. BOLAND. But it is going to get worse.

Dr. MERRELL. It is my hope it won't, but if it does, at that time, one does have to make some decisions.

Mr. BOLAND. It is going to get worse because of Gramm-Rudman. It seems we ought to come to a decision whether or not it would be more efficient to keep some open and close another, to be sure the observatories are working at the best level possible.

Mr. BLOCH. That is exactly right. As we move into 1987 with whatever 1987 will bring, we have to look at all of our facilities to make sure that we support them adequately and where we can't that we don't want to suboptimize, but close some of them down.

That is in the offing if 1987 is as bad as some people say they will be. Let me just get back to Sac Peak. Sac Peak has been looked at by almost everybody.

I will put it that way. I don't know anybody who has not looked at it in the last year.

It has been a controversy because of the Director of Sac Peak. When he first came into office, and then saw the budget problem in 1986, he essentially took the view that Sac Peak should be closed.

He was overturned by his Board, no doubt about it. The Foundation was not asked by him prior to his making the decision and we supported the Board in its conclusion. We have curtailed the operation in total among all of the observatories to essentially squeeze them down to a point where we can afford them and where they are still effective as Dr. Merrell mentioned a few minutes ago.

If we get into more kinds of squeezes, then I think we have to bite the bullet one of these days and close one or the other of these installations. Which one I wouldn't want to say, I can't say right now.

I think it depends on the cut that we have to absorb in this particular area and it depends on circumstances and it depends on the science priorities.

Mr. BOLAND. Let me ask one thing about the National Science Foundation. This is not a political problem, is it? You don't get any pressure from anybody up here on the Hill to keep—

Mr. BLOCH. Mr. Chairman, we live in a real world.

Mrs. BOGGS. I think you should study this.

Mr. BOLAND. This is a nice time to get lunch. Thank you very much.

AFTERNOON SESSION

NEW TECHNOLOGY TELESCOPE

Mr. BOLAND. The Committee will come to order.

Last year we had a lengthy discussion about what you were spending on the new technology telescope. That appears on page 193 of last year's hearings. You indicated that there was an allocation of an additional \$500,000 for studying the new technology telescope, bringing that effort to about \$3.1 million in 1986. Are those numbers still accurate?

Dr. MERRELL. The new technology telescope is part of the advanced development program at NOAO. The part that is actually going for the new telescope technology work is about \$2.2 million.

Mr. BOLAND. Are there any funds in the 1987 budget for this telescope?

Dr. MERRELL. For development work on optics, there is \$2.2 million.

Mr. BOLAND. Are there other funds for any other new telescopes in this activity or in other activities in this directorate?

Dr. MERRELL. For new telescopes?

Dr. BOLAND. Yes.

Dr. MERRELL. No, sir, not specifically for new telescopes.

[The information follows:]

NEW TELESCOPES

However, the Astronomy Project Support element receives, and currently has under consideration, proposals from universities for construction of moderate aperture optical and radio telescopes. These university projects are examined, in competition with other proposed instrumentation projects, within the Astronomical Instrumentation and Development subelement for support during the fiscal year. It is possible, based on our assessment of the scientific merit of such a telescope project and its cost, that it could receive approval for support with funding from within that budget subelement during the present fiscal year or during FY 1987.

VERY LONG BASELINE ARRAY

Mr. BOLAND. We will turn to AAEO-I-9. Here you are discussing the very long baseline array. In the 1987 budget highlights you indicate that two antennae are to be procured. You also indicate that the 1987 request will be \$9,400,000 for the continuing construction of the VLBA at the 1986 level of effort.

Subsequent to the submittal of the budget justifications, we received a letter from Laura Bautz indicating that it was your intention to increase the antennae procurement from two to three in 1986, making the most effective use of the \$9 million available for construction of the VLBA during this year. Since the sequestration has impacted that \$9 million by another \$450,000, does that mean

that you have to again look at whether you can buy three antennae?

Dr. MERRELL. We did look at that and we are able to buy three. We can defer some long lead time items and that enables us to take advantage of a good fixed price contract and that is the reason we are attempting to do that.

That will mean that we will probably only be able to purchase one or two antennae in 1987, but we still feel that is the most cost effective way to approach that problem.

ATMOSPHERIC SCIENCES

Mr. BOLAND. On page AAEO-II-1 under Atmospheric Sciences, you are requesting \$100,650,000 in 1987. That compares with the current plan of \$97,649,000 and a current level under Gramm-Rudman of only \$92,618,000. On page II-2, you discuss some of the impacts of the lower funding level than was anticipated in 1986 before the Gramm-Rudman impact. What further items will have to be cut in order to meet the Gramm-Rudman level?

Dr. MERRELL. We are cutting NCAR quite a bit. We are going to lose some more positions and we are cutting down on field program support.

Mr. BOLAND. Can you indicate specifically for the record where the cuts will be made?

Dr. MERRELL. Sure. Would you like that now or would you like me to provide it for the record?

Mr. BOLAND. You may do that for the record. This is one of the areas we will be looking at closely.

[The information follows:]

EFFECT OF GRH REDUCTIONS IN ATMOSPHERIC SCIENCES

The Genesis of Atlantic Lows Experiment (GALE), conducted during January-March 1986, was protected against reductions. To achieve the GRH reduction, approximately 25 proposals will not be awarded, resulting in loss of support for about 35 senior scientists, 10 post docs, and 25 graduate students. In addition, about \$850,000 will be lost to the infrastructure of atmospheric science, including about \$315,000 for equipment and instrumentation.

NCAR protected two items: \$5,000,000 for the X-MP/48 system and \$350,000 for UNINET. The remaining pro-rata reductions will have these specific impacts:

Twelve (12) scientific visitor appointments will be eliminated.

Director positions in the Administration and Scientific Computing Divisions will remain vacant.

Most vacant positions will remain unfilled. Impact is 10 FTEs. All salaries are frozen.

Acquisition of new and replacement equipment and instruments will be postponed to other fiscal years.

The UAF reduction will be \$181,000. This reduction will be taken in both scientific manpower and operations of the radars resulting in 15 percent fewer operational hours at the Sondrestrom Radar Facility. The total number of FTE scientists supported by the UAF will be decreased by 27 percent. This will involve freezing 2.5 vacant positions and terminating 1.5 on-board scientists.

NCAR COMPUTER

Mr. BOLAND. On II-5, the National Center for Atmospheric Research is discussed. Did you move an additional \$1 million to the scientific computing line in 1986 from the Advanced Scientific Computer Directorate for the new NCAR computer?

Dr. MERRELL. Yes, sir.

Mr. BOLAND. How much in total does that make available in 1986 for the new supercomputer in NCAR?

Dr. MERRELL. I believe that is \$5.0 million in 1986, and in 1987, it is \$6.5 million.

Mr. BOLAND. There is some suggestion that the National Center for Atmospheric Research is supporting an \$18 million purchase of a supercomputer for the VLA and the VLBA. Is that true?

Dr. MERRELL. No, sir. Not to my knowledge whatsoever.

Mr. BOLAND. Has there been any indication by that Center for money for the purchase of a supercomputer for VLA or VLBA?

Dr. MERRELL. No. The supercomputer for Atmospheric and Ocean Science is being purchased but nothing for Astronomy. NRAO had proposed to us at one time to purchase a supercomputer, but that was not through NCAR.

CONTINENTAL LITHOSPHERE PROGRAM

Mr. BOLAND. Under Earth Sciences on AAEO-III-1, there is a program sub-element known as Continental Lithosphere where you are requesting an increase of \$4,110,000 in 1987 over the current 1986 level of \$10.1 million. All other areas of the Earth Sciences sub-element essentially are frozen at the 1986 levels to compensate for the significant increase in the Continental Lithosphere program. Was that decision approved by the earth sciences community, and are they in agreement with that allocation?

Dr. MERRELL. Yes, sir. We have discussed that decrease with the various advisory groups who give us advice in that area. We have also—in response to the National Science Board—prepared a publication and a briefing on the Continental Lithosphere program. I think there is a very wide agreement in the earth sciences community that this is exactly what we should be doing. I am convinced of that.

Mr. BOLAND. Now, a year ago we asked about the significant increases in continental lithosphere. In that discussion I asked Dr. Bridgewater whether or not the earth sciences community was in agreement with this disproportionate funding share; he indicated that they would accept it as long as it was a one-year phenomenon. It does not sound like it is going to be a one-year phenomenon, or is it?

Dr. MERRELL. I don't think so. I think it is important to continue funding in this area.

I think this is a critical area. I support an increase in the funding in this area and I think that earth scientists do think that this is a place we should put extra funds.

I think the Continental Lithosphere program is the place to put it.

Mr. BOLAND. Let me ask you again whether or not this is still the position of the earth sciences community.

Dr. MERRELL. Yes, sir. The advisory committee agrees.

Mr. BOLAND. Are you familiar with Dr. Bridgewater's testimony?

Dr. MERRELL. I read Dr. Bridgewater's testimony.

Mr. BOLAND. He indicated, and I am sure he is talking about the community, "they ought to get a look at the history of this program and realize this is an intermediate phase, and hopefully a

one-year phenomenon and next year those other programs will experience a normal inflationary growth to address the issues in that area."

You don't have any problem with that? That is Dr. Bridgewater's testimony.

Dr. MERRELL. I understand what Dr. Bridgewater said. I don't have any problem with it.

[The information follows:]

PRIORITIES IN EARTH SCIENCES

In 1983 the National Academy of Sciences/National Research Council (NAS/NRC) completed a survey of the field of earth sciences research entitled *Opportunities for Research in the Geological Sciences*. This report identified study of the continental lithosphere as "... of overriding importance and priority," and recommended increased Federal support for a series of new "Major Experimental Projects and Facilities." Solid Earth Sciences was chosen the same year by the NAS/NRC Committee on Science, Engineering, and Public Policy (COSEPUP) as the subject of one its annual research briefings to Administration officials. Their conclusions were the same.

The Foundation's response to these recommendations was the formation in 1984 of new programs in Instrumentation and Facilities, and Continental Lithosphere. Plans for these programs were reviewed and approved by a special NSF Advisory Committee in July 1984. Both the NAS/NRC studies and the NSF Advisory Committee emphasized that the new programs required additional funds and should not be taken from existing individual grant programs. The Foundation has followed this guideline, and its budget requests for 1985, 1986, and 1987 show no decrease in funding for the eight individual grant programs in the earth sciences. In the request for FY 1986, as Continental Lithosphere projects were just beginning to get underway, individual grant programs were held to constant budgets. As stated last year by Dr. Bridgewater, this was a one-year transitional necessity. These programs were further protected from actual cuts as all Congressionally mandated cuts (except for Gramm-Rudman-Hollings cuts) were absorbed by other programs. The FY 1987 request shows requested increases averaging 5.6 percent for these programs in addition to the requested increase for Continental Lithosphere.

The Foundation considers it a desirable long-term goal for about half of earth sciences funding to be devoted to instrumentation, facilities, and major coordinated projects as represented by the Instrumentation and Facilities, and Continental Lithosphere programs. Such a ratio would be comparable to that of other observational sciences such as astronomy (67%), atmospheric sciences (49%), and ocean sciences (52%). At present, this ratio for earth sciences is 31 percent.

Funding for the Continental Lithosphere programs still falls well short of recommended levels so that emphasis on this program is expected to continue.

OCEAN DRILLING PROGRAM

Mr. BOLAND. We will turn to the Ocean Drilling Program. That is AAEO-IV-1.

In this program you are requesting \$30,050,000 in 1987. As you know, we have asked you to protect the \$28,850,000 in the current plan until we know whether the European scientific community will come in as a sixth partner contributing \$2.5 million.

Is there anything new you can report to us on those negotiations and where they stand?

Dr. MERRELL. They are going quite well. They are up to something like 90 percent of the full price, but they have not joined as of right now, but things do look very, very good.

Mr. BOLAND. How good does it look?

Dr. MERRELL. I think they look excellent. That is my personal assessment, but I remember that we thought that Great Britain was going to join for many months before they actually did.

I think the eventual joining is very probable. The timing is very questionable.

Mr. BLOCH. We would like to see the signature on the piece of paper.

Dr. MOORE. And the check in hand.

Mr. BOLAND. Last year it was indicated that the Soviet Union might be permitted to join the drilling program, and Dr. Bridgewater indicated some informal contacts had been made. What is the status of those negotiations, if there are any, with the Soviet Union?

Mr. BLOCH. Let me take that. I wrote a letter to the Soviet Academy of Science a few months ago. I think to be exact, it was in the December time frame after Geneva, inviting them to join this particular program.

To date I have not gotten an answer.

Mr. BOLAND. On IV-6, the justifications indicate that the costs for the Ocean Drilling Program in 1986 were underestimated, but that a sixth international member would meet these shortfalls. How much were the costs understated in 1986, and what was the impact of that?

Dr. MERRELL. I don't want to avoid the question, but I think I am into a conflict of interest situation. I was the principal investigator of the program at the time.

Mr. BLOCH. I think it is proper for Sandra to answer that question.

Mr. BOLAND. Sure. You may supply it for the record.

Ms. TOYE. I prefer to do it for the record, because I have been isolated from that program for several months. There were some underestimates in the engineering area, some others of that sort, but I prefer to do that for the record.

[The information follows:]

OCEAN DRILLING PROGRAM

The FY 1986 budget request together with contributions from five international members was expected to support the ocean drilling program at the level required for continuous, long-term drilling operations including all associated logistics and scientific services. The program started operational drilling in January 1985 and detailed analysis of actual costs and continuing requirements were done during the year by the NSF and international members. The FY 1986 budget was structured to meet all immediate operation and engineering development efforts. There are no significant negative impacts in 1986 and all members are satisfied with the scientific progress and operations.

The "underestimated" budget requirements take effect in FY 1987. Full costs for publishing the scientific results of the drilling require an increase of \$1,300,000. This includes filling all editorial and production staff positions together with production and distribution of the books. Engineering and drilling staff with support for new technology need to increase by 20 percent for long-term development (\$920,000). The drillship operated in FY 1986 in the North Atlantic with simple logistics support. Drilling in FY 1987, FY 1988 and FY 1989 includes high latitude sites in the Weddell Sea off Antarctica, the Indian Ocean and Western Pacific. Logistics and technical support for operations in these remote regions increases annual costs by \$500,000. Minor cost saving in other program elements are offset by inflationary increases of about four percent for most base costs. The increase required for a stable, long-term fully operational program is \$3,700,000 over the FY 1986 base. The sixth international member is providing \$2,500,000 of the increase.

INDEMNIFICATION OF ODP

Mr. BLOCH. Are you leaving the ocean drilling area?
Could I make a comment that pertains to it?

Mr. BOLAND. Yes.

Mr. BLOCH. As you know, we have an indemnification agreement with the drill ship operator. Such an indemnification agreement is standard and reasonable practice in that particular industry. The purchaser of services bears the risk of it. He also then has the benefit of determining where he wants to drill and not be at the mercy of the operator.

So that is really the reason for it. I don't believe we have a very great exposure in this particular area because, as you know, we are not drilling for oil or gas or anything like that.

In fact, the ship is not suited to do that anyway. If there is an indication of any problems of that sort, we abandon that particular drill hole and move on somewhere else. But I think it is very important that we continue the indemnification clause that we have, in order to preserve as much freedom of action as we need in order to direct the drill ship to the areas that are of scientific interest.

I just wanted to mention that before we move on to another subject.

Mr. BOLAND. We put language in the bill for it anyway, but we will have to get agreement in another forum.

Mr. BLOCH. Right. I appreciate that.

Mr. BOLAND. That is easy, isn't it?

Mr. BLOCH. I think it is easy with your support.

ARCTIC RESEARCH COMMISSION

Mr. BOLAND. On AAEO-V-2 under the Arctic Research Program, you are requesting a 66 percent increase in the Arctic Research Commission budget. How much have we provided for the Commission to date, and why is there a request for such an enormous increase?

Dr. MERRELL. Peter Wilkniss.

Dr. WILKNISS. I am Peter Wilkniss. Sir, the Commission was established last year as a Presidential Commission, and the first year of funding provided by your Committee and the Senate Committee was \$150,000. There was a supplemental appropriation making it \$250,000 with a ceiling being placed on the Commission in 1986 for \$300,000 and, of course, this will be the first year that the Commission is in full operation. The budget contains a request for \$500,000, so that they can properly structure their activities including opening a branch office in Alaska and carrying out the international activities that the act prescribes.

Mr. BOLAND. Why do you need a branch office in Alaska?

Dr. WILKNISS. Sir, it was the strong desire of the Alaskan delegation and the political forces behind the Act that Alaska, being the only Arctic State in the Union, would be the appropriate place for the Commission to be housed. This did not come about, but it turns out that the major activities under the Act are between the Federal, State and local governments and the private industry. Again, Alaska being our Arctic State, the Governor of Alaska has agreed

to cost share in this office if the Commission sets it up in Anchorage. It will be placed at the University of Alaska.

Mr. BOLAND. We had some information in the hearings last year on the Arctic Commission, didn't we? The Foundation itself doesn't feel any pressure that this Commission can get whatever they ask for?

Mr. BLOCH. No. Let me tell you. I am an ex officio member of that Commission. Let me tell you about the agreement that we have with the chairman of the Commission, Dr. Zumberge.

It is very simple. Rather than going into Congress on his own with his own appropriation request, which does not seem right because of the total money involved, the National Science Foundation would fold it in, would show it as a line item in its own budget. The chairman, however, justifies the need for it to Congress, as well as to OMB.

So that has been the arrangement. This is a technical arrangement. We think it is think is very good because it saves him overhead. It saves us on overhead, and we are the carrier of information, but he has to justify it.

I must say I have attended a meeting of that particular Commission last November. It had a slow start, but it is moving and I think the Commission is doing some really good work.

Mr. BOLAND. How many Alaskans are on the Commission?

Mr. BLOCH. Three.

Mr. BOLAND. Do you want to supply for the record the members of the Commission? Are they all happy with it?

Dr. WILKNISS. On the average, yes, sir.

[The information follows:]

ARCTIC RESEARCH COMMISSION

The members of the Arctic Research Commission are: Dr. Oliver Leavitt, Arctic Slope Regional Corporation; Mr. Elmer E. Rasmuson, National Bank of Alaska; Dr. Juan Roederer, University of Alaska; Dr. Lincoln Washburn, University of Washington; and Dr. James H. Zumberge, University of California. Dr. Zumberge is the chairman of the Commission.

Mr. BOLAND. Are you happy with it, Peter?

Dr. WILKNISS. Yes, sir.

Mr. BOLAND. I am trying to think of one geologist who is a member of the Commission. Obviously you have got some pretty good people on there, so good luck to you. Where do you meet in Alaska?

Dr. WILKNISS. The Commission has held hearings all over Alaska, Barrow, Prudhoe Bay, Anchorage, Fairbanks, and this coming April they want to go to Kodiak and the other areas of Alaska to get the indigenous people and the different sections of Alaska involved.

SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS

Mr. BOLAND. OK. We will turn to the Scientific, Technological and International Affairs Directorate on page STIA-1. You are requesting \$47,030,000 in 1987. On STIA-1 and 2, there is an indication that you were forced to increase the small business innovation research from the original 1986 estimate of \$13.3 million to \$16,650,000 based on a requirement in Public Law 97-219. That was passed

before the 1986 budget was formulated. Why wasn't the \$1.2 million requirement carried in your budget request?

Mr. RICHARD GREEN. That was due to an underestimation at the time and it was rectified subsequently.

SMALL BUSINESS INNOVATION PROGRAM

Mr. BOLAND. That small business innovation research, I think, was a proposal which was initiated Congressionally, is that correct?

Mr. RICHARD GREEN. That is correct, sir.

Mr. BOLAND. Has it been useful?

Mr. RICHARD GREEN. I believe so, but I am an advocate of it, so I don't know if I should speak to that.

Mr. BOLAND. In comparison to some of the other items in this directorate, is it important?

Mr. RICHARD GREEN. Yes, very important, sir.

Mr. BOLAND. Was the entire increase of \$2,350,000 in this activity derived from within the STIA directorate and, if not, where was it derived from?

Mr. RICHARD GREEN. That was allocated to the program by the director's office. It did not come out of STIA.

Mr. BOLAND. What about that number? My understanding is it has been reduced by about five percent as a result of Gramm-Rudman; is that correct?

Mr. RICHARD GREEN. Yes, sir.

Ms. TOYE. May I make one technical point before we leave that question, Mr. Chairman?

Mr. BOLAND. Yes, sure.

Ms. TOYE. There was at issue at one point a question of technical interpretation on the Small Business Innovation Program, and that is why the one percent was used in the original budget submission. There was an issue, a discussion at OMB about the applicability of the full one-and-a-quarter per cent. That was determined after the original submission and we immediately increased it to comply with the provisions of the law.

INDO-U.S. SCIENCE AND TECHNOLOGY PROGRAM

Mr. BOLAND. OK. On to the International Cooperative Scientific Activities. We can see that the 1986 original request was reduced by \$1,250,000, I suspect, again, owing to another of your numerous reprogrammings, by removing the Indo-U.S. Science and Technology Program to the Atmospheric Sciences sub-activity where, I gather, it is not carried by line item but is buried in the budget; is that correct?

Mr. RICHARD GREEN. STIA has been assigned the Executive Agent responsibility for the Indo-U.S. Science and Technology Initiative and the funding for the NSF research activities conducted under the initiative, has been placed in STIA in the FY 1987 Budget Request. There is an additional set of funds in the STIA budget in addition to the research support which provides support for an overview committee of the National Academy of Sciences plus some other activities both within and outside the Foundation related to STIA's Executive Agent responsibilities under the initiative.

Mr. BOLAND. This request, as I look at the justifications, is an 18 percent increase consisting of almost \$2 million. The justification indicates that the Indo-U.S. Science and Technology initiative is included in the program element; is that correct?

Mr. RICHARD GREEN. That is correct.

Mr. BOLAND. Is the Indian program in this activity?

Mr. RICHARD GREEN. We have the responsibility for oversight of the science and technology initiative within STIA. For FY 1987 for the NSF activities under the Initiative are in the STIA budget accounting for most of the nearly 18% increase in this program element over FY 1986 funds. Part of these funds will be transferred to AAEO for the activities in the monsoon program; an additional part will be transferred to ENG for the NSF portion of the new solid state science and engineering program.

Mr. BOLAND. Of the almost \$12 million requested for this program element, will you supply for the record a break-out of that figure?

Mr. RICHARD GREEN. Yes, Mr. Boland.

[The information follows:]

FUNDING OF INDO-UNITED STATES S&T INITIATIVE

The \$12.66 million request for International Cooperative Science Activities includes \$2.00 million for NSF funding of the Indo-U.S. Science and Technology Initiative. Of this amount, \$1.5 million will be transferred to the Division of Atmospheric Sciences to support the monsoon research component of the Initiative. Another \$200 thousand will be transferred to the Engineering Directorate for support of research in minerals engineering under the solid state science and engineering component of the Initiative (which also includes photovoltaic research supported through DOE). The remaining \$300 thousand will be expanded by NSF for expenses associated with its role as Executive Agent for the Initiative, including support of the National Academy of Sciences Advisory Committee.

In the FY 1986 Current Plan, funds for the monsoon research component were reallocated to the Atmospheric Sciences subactivity. Inclusion of these funds in the International Cooperative Science subactivity in the FY 1987 budget request accounts for most of the 16.8 percent increase over the FY 1986 Current Plan shown for this program element.

IIASA

Mr. BOLAND. Last year this Subcommittee worked with the Foundation to help restore funding for the International Institute of Applied Systems Analysis. I believe \$500,000 was provided in 1986 for that organization, but on your insistence from within other directorates, rather than from this directorate where it was separately identified before 1982. Why have you chosen to fund IIASA in this manner?

Mr. BLOCH. The history of IIASA funding is a long and torturous one, as you know. When we started discussing it a year ago roughly—or longer by now—more a year-and-a-half ago, with the new director of IIASA, Dr. Lee, what the relationship should be, we both came to the conclusion that the best thing that we could do is have a programmatic relationship and not support just institutional support in an undefined way.

We have been working in that particular direction and what we have right now in 1986 is a proposal from IIASA, in a programmatic area. It has been reviewed through the peer review process, and it has passed that particular process. It is now in the Department

of State awaiting approval from there, because they have the last say in the matter, as you know.

Therefore, I think it is very important that we keep the relationship between the science directorates and IIASA as well as between STIA and IIASA alive. In fact, we are forcing that relationship so that we can have this positive relationship rather than just supporting an institution at arms length.

Those are the reasons why we are putting the funding where the funding is.

Mr. BOLAND. Is there any assumption in the 1987 budget for IIASA?

Mr. BLOCH. The planning assumption is they will come in with programmatic proposals again, and my assumption is right now without knowing what they are going to come in with, it will probably be on the same order as in 1986, but we have to see what is coming in as part of the 1987 plan.

Mr. BOLAND. Dollar-wise?

Mr. BLOCH. That is what I said, about the same as 1986, but we have to see what the submission is. Obviously it depends on our total budget.

U.S. MEMBERSHIP IN IIASA

Mr. BOLAND. What is the Administration's position with respect to the U.S. becoming a full member in IIASA? Is that being determined now?

Mr. BLOCH. No. I don't know if it is being determined now. The letter that changed the relationship a few months ago was from Secretary Shultz who said that there is no problem with having programmatic relationships, specific relationships, project kind of relationships with IIASA and, in fact, he encouraged the various agencies to have that kind of relationship.

That is when we moved forward with our discussions. I don't think there is any discussion right now. I am not aware of any discussion right now for a pro forma membership for the United States.

Mr. GREEN [presiding]. If the Administration should decide to join again, wouldn't it require more than \$500,000?

Mr. BLOCH. It would depend on the fee structure. There are discussions underway within IIASA right now on that point: what is an appropriate fee structure, because there are some inadequacies in the fee structure as it exists. Some countries are not paying what I would call their fair share. I am repeating what I hear: Japan pays the same fee as Hungary, which does not sound quite right.

So there are some problems with the fee structure itself. In fact, there are discussions under way and I don't know what the outcome will be of that discussion.

So it is true that more money would be required if we were a full-fledged member. How much will depend on some of these discussions that are going on.

Mr. GREEN. What is assumed in the 1987 budget for IIASA?

Mr. BLOCH. As I said, our assumption is that it will be around the same as in 1986, depending on the proposal that we are going to get. We have to look at that proposal.

POLICY RESEARCH ANALYSIS/SCIENCE RESOURCES STUDIES

Mr. GREEN. On pages STIA-III and IV are Research and Analysis Program and the Science Resources Studies Program. On reading the justifications, it sounds somewhat like the role and mission of Office of Science and Technology Policy. What do these activities do? Also, could you provide for the record how you would fund these activities with a 25 percent reduction?

Mr. RICHARD GREEN. All right.

Mr. BLOCH. Do you want us to comment or write it for the record?

Mr. GREEN. If you would comment on what they are doing and provide for the record how you would restructure the 25 percent reduction.

[The information follows:]

FUNCTION OF PRA AND IMPACT OF REDUCTION

The Division of Policy Research and Analysis (PRA), in the Directorate for Scientific, Technological, and International Affairs (STIA), is responsible for analyzing the effects of past, current, and alternative national policies for the promotion of research and education in science and engineering. This mission directly supports the NSF Director and the National Science Board in executing their responsibilities specified in Section 3(d) of the NSF Act, "... shall recommend and encourage the pursuit of national policies for the promotion of research and education in science and engineering."

To reduce costs and preclude unnecessary duplication of efforts in the Executive Branch, PRA conducts science and engineering policy analyses at the request of units in the Executive Office of the President, such as the Office of Science and Technology Policy (OSTP), the Office of Management and Budget, and the U.S. Trade Representative. Provision of such services to OSTP is specifically authorized in the OSTP organic act (P.L. 94-282), and provision of services to other agencies is generally authorized under Section 3(b) of the NSF Act. Through the NSF Director, PRA provides results of such policy analyses at the request of legislative branch staff offices, such as the Congressional Research Service, the Office of Technology Assessment, and the General Accounting Office.

PRA's policy analysis function uses data gathered by its companion division (SRS), as well as information collected by many other Federal agencies and national professional and trade associations, in conjunction with state-of-art analytical techniques to provide analyses of specific policies to requesting officials on a timely basis. PRA is currently studying several of the issues being debated in the House Science and Technology Committee hearings on basic research, such as geographic distribution of funds, supply and demand for scientific and engineering personnel, and financing of university facilities and equipment. The science policy research phase of the PRA program consists of longer term studies to maintain and enhance the knowledge base, and to develop improved analytic techniques. Most of this work is conducted by university professors and graduate students.

PRA has already sustained a severe reduction in resources: the FY 1986 budget is only 40% of FY 1985, and the staff size suffered a similar cutback. Through effective application of modern computing technology, judicious staff management, and substantial reduction of research activities, PRA has been able to sustain a credible and useful service function, although the number of individual requests answered has significantly declined, including requests from OSTP staff.

Another 25 percent reduction in the budget would require virtual elimination of science policy research at NSF. The remaining resources would be fully dedicated to short-term analysis of current issues. This strategy minimizes the short-term impacts of the reduction, but a rapid degradation of the quality and credibility of future analyses will be experienced as new problems are addressed.

FUNCTION OF SRS AND IMPACT OF REDUCTION

The Division of Science Resources Studies (SRS), which resides in the Directorate for Scientific, Technological, and International Affairs (STIA), is responsible for carrying out functions pertaining to the collection, analysis, and dissemination of information on the Nation's personnel and financial resources devoted to scientific and technological activities. This responsibility is contained in the National Science Foundation Statutory Authority, February 1986. Specific references to this mandate include the following:

"To evaluate the status and needs of the various sciences and fields of engineering as evidenced by programs, projects, and studies undertaken by agencies of the Federal Government, by individuals, and by public and private research groups ..." (SEC.3.{a}{5})

"... to provide a central clearinghouse for the collection, interpretation, and analysis of data on the availability of, and the current and projected need for, scientific and engineering resources in the United States, and to provide a source of information for policy formulation by other agencies of the Federal Government ..." (SEC.3.{a}{6})

"To initiate and maintain a program for the determination of the total amount of money for scientific and engineering research, including money allocated for the construction of the facilities wherein such research is conducted, received by each educational institution and appropriate nonprofit organization in the United States, by grant, contract, or other arrangement from agencies of the Federal Government, and to report annually thereon to the President and the Congress." (SEC.3.{a}{7})

"The Board shall render to the President, for submission to the Congress no later than January 15 of each even numbered year, a report on indicators of the state of science and engineering in the United States." (SEC.4.{j}{1})

"By January 30, 1982, and biennially thereafter, the Director shall simultaneously transmit a report to the Congress ... and the Secretary of Health and Human Services." The report required by this subsection is to contain:

"(1) an accounting and comparison, by sex, race, and ethnic group and by discipline, of the participation of women and men in scientific and engineering positions ..."

"(2) an assessment, including quantitative and other data, of the proportion of women and minorities studying scientific and engineering fields, including mathematics and computer skills, at all educational levels;"

"(3) such other data, analyses, and evaluations as the Director, acting on the advice of the Committee on Equal Opportunities in Science and Engineering, determines appropriate to carry out the Foundation's functions as well as the policies and programs of this Act." (SEC.37.)

Additional data collection and analysis activities have been mandated for the NSF and assigned to SRS as follows:

"The National Science Foundation is authorized to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities ... The Foundation, in conjunction with other appropriate Federal agencies, shall conduct the necessary surveys every 2 years and report the results to the Congress ..." (Section 108 of P.L. 99-159)

"... develop indices, correlates or other suitable measures or indicators of the status of scientific instrumentation in the United States and of the current and projected need for scientific and technological instrumentation." (Section 7 of P.L. 96-44)

SRS carries out activities that respond to the information needs of policy makers as expressed in the references above through a series of surveys of individuals and institutions involved in the performance or funding of science, engineering, and technological activities. These surveys are carried out under contract with private sector organizations and other Government agencies. Data obtained from these surveys are analyzed and disseminated to Federal policy makers and the public in reports such as Science Indicators and Women and Minorities in Science and Engineering. The Division also disseminates special studies on selected science and technology issues prepared by SRS staff or outside experts.

The two reports cited above, both of which are congressionally mandated, depend upon inputs from virtually all data collection and analysis activities of SRS. Therefore, any reduction in such activities will necessarily have a serious impact on the quantity and quality of information available for these mandated reports.

The proposed budget for SRS for FY 1987 (\$4.2 million) represents, after adjustment for inflation, a level 10 percent below the FY 1979 budget. A 25 percent reduction in SRS funding would put the SRS budget at two-thirds the FY 1979 level in constant dollars. It should be noted that, since 1979, the requirement for the Women and Minorities in Science and Engineering report and two major data systems, Academic Research Instrumentation and Academic Research Facilities, have been assigned to SRS.

A 25 percent reduction from the proposed FY 1987 level would leave sufficient funds for the development of national estimates for either scientific and technological personnel or for U.S. R&D expenditures. It would not be possible to do both. It should be noted that without the S&T personnel data, it will be impossible to produce the report on women and minorities. In addition, it would require SRS to eliminate its research program for the development of additional science and technology output indicators, all modeling and projection activities, the industry and university quick-response survey mechanisms which provide a means of obtaining answers to current policy questions on a quick turnaround basis.

Finally, SRS would need to set aside plans to obtain the services of outside experts such as the Committee on National Statistics of the National Academy of Sciences for help in evaluating and designing the Division's program for the collection and analysis of science, engineering, and technical data during the decade of the nineties.

POLICY RESEARCH ANALYSIS/SCIENCE RESOURCES STUDIES

Mr. RICHARD GREEN. The policy research activities provides a whole range of analyses for the director, the National Science Board, OSTP and the OMB. We have been looking at issues concerning the geographic distribution of research funds, the issues of supply and demand for scientists and engineers, and what the projections are for the future. We are also looking at Japanese technology development and studying U.S. academic research instrumentation issues.

Under the Science Resource Studies subactivity, there is a whole host of programs. I know the Committee is familiar with the *Science Indicators Report*, and the *Women and Minorities Report*, which show the numbers of Ph.D.s in various fields of science and engineering and Federal R&D obligations by activity. We also provide major support to OMB in developing the special analysis of the R&D portions of the budget and so forth.

So that is a sample. I can go on. There are about 50 or 60 of these, if you care to hear them, but I don't think you do. I should add, however, that this is not a policy research unit; its function is to provide information for use in policy research.

Mr. BLOCH. Let me just comment on the Science Resource Studies sub-activity. The report which you cited yesterday, Mr. Green, *Science Indicators*, is the product of that particular group. What we are trying to do there is make sure that we are showing a total picture of the science and engineering enterprise in the United States, especially for Congressional use and for Administration use, but also it has usage in the private sector and in the academic sector.

It is being cited over and over because—over a long period of time—it has established a high reputation for accuracy. So what it is really supplying is many of the basic data points and data bases that are required to formulate a science policy for the United States, so it is a very important activity.

It is widely in this particular country, and even overseas. Many of the overseas countries are trying to build up that same capability for themselves because they are seeing the value of it and the need for it.

MINORITY RESEARCH CENTERS OF EXCELLENCE

Mr. GREEN. Under the Research Initiation Improvement subhead, I notice that you have a new program of \$4 million for Minority Research Centers of Excellence. It is my understanding you plan to pick four centers in fiscal year 1987 and fund them at \$1 million each for five years; is that correct?

Mr. RICHARD GREEN. That is the general plan, sir, yes.

Mr. GREEN. Are these centers planned to become self-sustaining after five years?

Mr. RICHARD GREEN. That matter has not been completely resolved. Let me give you a little background. There are approximately 20 eligible minority institutions. This would be akin to the EPSCOR program, which is trying to build competence within several institutions in a State. We are talking about building competence within an institution, and this would start out with a self-analysis, if you will, under a planning grant from the Foundation

to approximately 20 institutions which have received research initiation awards from the Foundation. It would be for a one-year self assessment in which they would look at the need to develop their research facilities, their faculty, and programs to attract new faculty and programs to train both graduate and undergraduate students.

Their competition would end after a year. Decisions would be made on funding up to four or five of these centers at a million dollars a year for a five-year period. Depending on the results of a mid-term assessment, which is built into the program, we would be better able to determine what the future would be as far as funding is concerned.

It is an experimental program. I must emphasize that.

ADVANCED SCIENTIFIC COMPUTING

Mr. GREEN. Turning to Advanced Scientific Computing on page ASC-1, you are requesting \$53,630,000. We had a fairly lengthy discussion on the supercomputer issue last year, and I want to take a minute to have you bring us up-to-date on where you might stand.

If I recall it correctly, you funded in 1985 and 1986—I think that was the testimony yesterday—five plus one of what are called Phase I centers. Those centers are at Minnesota, Colorado State University, Purdue, Boeing Computer Services, AT&T Bell Labs and Digital Productions.

Last year I believe you told us that you have three of these interim centers planned and those plans were for only two year grants to fill the gap until the permanent centers, known as Phase II centers, came on line.

Why did you double the three interim centers to six, and what was the source of funds for those additional centers? Are you still planning to keep these open for only two years with Foundation funds?

Dr. CONNOLLY. Yes. Our plan was to provide resources to the community in the interim time until the national centers came on line. The national centers are just coming on line now. We required extra resources.

That is why we bought the time at the other three centers. In particular, the Colorado State is providing Cyber 205 time because the machine at Purdue is saturated. The Digital one was an unusual case and provided a particular capability that was not available to other centers especially in terms of advanced graphic software.

The Bell Labs provides some Cray-XMP time available only at the Boeing Center which has become saturated as well.

Mr. GREEN. Are you still planning to keep these open for only two years with NSF funds?

Dr. CONNOLLY. The commitment to these centers is only up to the end of 1986. We plan to, if this request goes through, have a small program in 1987, for resource centers to provide resources which can't be provided by our other centers.

Mr. GREEN. Could you spell that out a little more?

Dr. CONNOLLY. In the current budget plan for 1987 in this estimate you see before you, there is approximately \$2.3 million for providing resources which the Phase II centers cannot provide.

The Phase II centers you realize cover a finite number of different kinds of supercomputers. We can't cover all of the alternatives.

ASSIGNMENT OF NASA COMPUTER TO CARNEGIE MELLON

Mr. GREEN. Is it correct the fourth center at Carnegie Mellon and the University of Pittsburgh, I believe, is the center that is using the NASA computer?

Dr. CONNOLLY. The NASA computer was assigned to Carnegie Mellon some time last year. Towards the end of 1985, the Pittsburgh center, which is a consortium of Carnegie Mellon, University of Pittsburgh, and Westinghouse, sent us a proposal that it proposed to trade the NASA machine in on a more advanced supercomputer.

We examined that proposal, reviewed it and decided to go with that proposal instead of the original one.

Mr. GREEN. Where is the NASA computer now?

Dr. CONNOLLY. The NASA computer has been returned to Cray. We got \$3 million as a trade-in value on that machine.

Mr. GREEN. This is one of the areas in the 1986 budget that the Committee attempted to protect. I believe that has been successfully done.

Am I correct in stating that the advanced scientific computer function was protected both in the Congressional reductions and in the Gramm-Rudman reductions?

Mr. BLOCH. No. It is not protected in the Gramm-Rudman reduction.

Mr. GREEN. So you have taken the Gramm-Rudman reduction, but not the Congressional reduction?

Mr. BLOCH. Yes.

Dr. CONNOLLY. In addition to the 4.9% Gramm-Rudman reduction (\$2.2 million), there was also a reprogramming of \$1 million from Advanced Scientific Computing to the National Center for Atmospheric Research for the purchase of their advanced vector computer.

Mr. BLOCH. Still, it was for the use of supercomputing.

Mr. GREEN. I gather the \$53,630,000 requested in 1987 does not anticipate any additional centers?

Dr. CONNOLLY. That is correct.

JAPANESE COMPETITION IN COMPUTERS

Mr. GREEN. Are you familiar with Ruth Davis, who addressed the MIT club at GWU recently? She indicated we are going to lose our technological edge to the Japanese by 1990 if the Government does not do more to sponsor R&D projects in supercomputer work. Would you agree with her assessment?

Dr. CONNOLLY. I won't pretend to predict what is going to happen five years from now. At the present time I keep very close track of what is happening in the supercomputer business. At the present time, the U.S. supercomputer business is fairly healthy, but the Japanese suppliers have produced recently some excellent machines and there will be very strong competition.

How strong that competition is going to be in the 1990's, I don't know.

Mr. BLOCH. Let me jump in. I don't know if I agree or disagree with Ruth Davis, but I would say the following. Like in many other areas, we are under severe pressures by the Japanese. As you know, they have targeted the information industry as a very important industry for themselves. They have formulated programs like the fifth generation computer, which began a couple years ago and is still ongoing, to essentially jump ahead and get ahead in research as well as application.

So I think we should take it very seriously and I think Congress, by approving this particular program, has taken a lead in this particular area. We also, as you noticed, in this submission here, as well as in some of the previous years' submissions, we have increased to a very high level our involvement in computer research, not just providing cycles in supercomputing and also in computer engineering and also in information sciences. We have done that with the understanding that we are in a competitive situation.

By the way, if you take all these areas together that have something to do with computer research or supplying computer cycles, the increase in 1987 over 1986 is about 18 percent. So it is a significant increase.

You should also know that we have decided to reorganize this particular area in the Foundation. We have given you an indication that we are planning on doing so and asking for your agreement.

I think it is very important that we pull these four areas together that are now spread throughout the organization and treat them as a single directorate. First the dollars we are spending in that area are about \$130 million in 1987 if our request is approved.

It is a significant part of the total funding of the Foundation. Secondly, by putting them all in one directorate, I think we are going to get a better strategic view of what is required in the future.

Thirdly, we are not the only actor in this game. DOD has a very high investment in it and also some of the other agencies such as DOE.

We need to get better coordinated within the government and get a single kind of focus within the Foundation, I think that will help us greatly in accomplishing that. We are taking it very seriously.

FUNDING IN SUPERCOMPUTER R&D

Mr. GREEN. Is it possible to make any estimate of what we are spending on supercomputer R&D versus what the Japanese are spending?

Mr. BLOCH. I don't think you can make a very good estimate because the Japanese spending pattern in everything is a very complex one. What the Government puts in you will find is usually minimal. By minimal I mean maybe 20 percent of the total, not 50 or 75 percent.

What the rest of the industry then is spending under the guidance of the Government, you know, is a hidden ball, and then there are secondary kinds of funding provisions through the various independent research institutes in Japan which are government funded.

We have been trying to trace that in this particular area and in other areas. It is very difficult to do. But it is more than what the Japanese indicate they are spending.

Let me assure you of that.

U.S. ANTARCTIC PROGRAM ICEBREAKER SERVICES

Mr. GREEN. Let's turn to the U.S. Antarctic Program. You are requesting \$117 million in 1987. On page USAP-4, you have a table which breaks out the \$1,340,000 increase in operations work.

As the table indicates, you are transferring to the Coast Guard the cost of the icebreaker service. That appears to be a reversal of the concept of the past five to ten years, wherein preceding Administrations felt that all the costs of the Antarctic Program should be displayed under this one budget.

Why the reversal?

Dr. WILKNISS. Mr. Green, the responsibility for the Coast Guard icebreaker budget was transferred in fiscal year 1983 to so-called users which are made up of DOD, NSF and Maritime Administration. The concept at that time was that the user pays.

I think it worked after a fashion because you see, when you have an established a fleet of ships which is maintained by the users who all have a part of the budget, then it is difficult for the parent agency, the Coast Guard, to really do a good job managing the ships.

Additional bureaucracy was created, the so-called user council. So I should say the arrangement worked after a fashion. Now, the wishes of the Congress have been expressed in several pieces of legislation, the Arctic Research and Policy Act of 1984, the appropriation bill for DOD for 1986, and the Continuing Resolution in 1985, and all these pieces of legislation say that the Congress wants the fixed cost returned to the Coast Guard to get better management. Of course, it also says that the incremental cost that the users incur and pay on top of maintaining this standing fleet should be carried by the users.

I would like to get back to your direct question, why shouldn't the fixed costs be then with the NSF since the President has said and the Congress has agreed the Antarctic Program should all be managed in one place.

I think it is apparent now that we didn't really manage the icebreakers because we only had a small part of the Coast Guard icebreaker budget, maybe 30 percent. There are four or five ships. They work in the Arctic, and in the Antarctic, so I think the situation was not that we had all the resources. There was no icebreaker assigned to the Antarctic Program year-round that we could have managed as we manage the support we obtain from the DOD or our private contractor in a year-round fashion.

I think that would be my answer to your question.

ICEBREAKER OPERATING COSTS

Mr. GREEN. Do I infer from what you said that NSF is actually still paying some of the operating costs?

Dr. WILKNISS. Yes, sir. The arrangement that we are looking at now is that the money that was budgeted with DOD and NSF, for

the so-called fixed costs of maintaining a standing fleet of icebreakers, will be included with the Coast Guard request in FY 1987. We will pay for the fuel costs for these icebreakers to transit to the operating area, in our case 60 degrees south from mostly the West Coast. Then we pay for the fuel and maintenance surcharge while the icebreakers are either doing research under the Antarctic Program or breaking the channel for our supply ships and we pay a surcharge for the use of the helicopters in the research program or as part of our logistics system.

This you see now in our budget, \$2.8 million, of which \$1.2 million is budgeted for research use of the icebreakers, where scientists actually use the icebreakers as research platforms, and \$1.6 million is budgeted to pay for the icebreaker that breaks in the channel to McMurdo Station, the main supply hub in the Antarctic, where we cannot get in with our supply ships without the help of an icebreaker.

So the difference you see then is between \$15.2 million in FY 1986 and operating costs of \$2.8 million in FY 1987. This is a \$12.4 million difference in the budget. The transfer of projected fixed costs is \$14.4 million, which relates to the transfer from the Coast Guard in 1983 of \$13.4 million, so we have given them back about \$1.0 million more than we got in fixed cost from them in 1983.

TRANSFER OF OPERATIONS BUDGET TO COAST GUARD

Mr. GREEN. When you get through all that, is it accurate to say \$14.4 million has been transferred to the Coast Guard, so that the program has had a net increase for operations of almost \$15 million?

Dr. WILKNISS. Yes, sir. That is accurate. The base budget transfer comes to \$14.4 million and, as you see, what the President's budget proposes for the Antarctic Program to be added are, in my opinion, high priority, very necessary and prudent investments.

If I may elaborate on those, first of all, we are talking about the maintenance and upgrading of our aircraft fleet and we have now a plan. Mr. Boland admonished us last year that we hadn't done so well on getting ready for this. We now have our plan and the investment we are planning over the next five years would be equivalent to the cost of one new LC-130. We will be able to maintain and upgrade the fleet of 7 aircraft to make them last through the mid-1990s. So we don't have to come to you for new aircraft requests anytime soon, sir.

AIRCRAFT SERVICE LIFE EXTENSION PROGRAM

Mr. GREEN. While we are on that, I gather there have been some delays encountered in that aircraft program.

Dr. WILKNISS. Yes, sir.

Mr. GREEN. What was the cause of the delays and what has actually happened?

Dr. WILKNISS. As you remember, when we first came to you, we asked for a so-called service life extension programs, SLEP, which the DOD had entered—Navy had entered with Lockheed, Georgia, to upgrade about 51 KC-130 aircraft. When this project was com-

pleted the Antarctic aircraft were to be included in the second batch of ten aircraft.

Aero Corporation of Florida went to court, got an injunction and litigation ensued for about three-and-a-half years. When that was done, it was determined that the so-called SLEP program was not feasible anymore time-wise or cost effectively. The Naval Air Systems Command has now developed for us a program that upgrades the aircraft over several years in the course of depot level of Maintenance.

The request you see before you takes into account the first five million we received in 1984 that we have now spent on avionics and long-term procurement of essential aircraft components like wings and landing gear. The new request, you see, is to go through with this program, which will come to \$13.3 million during the next five years for the two oldest aircraft. We also are asking now for funding for design of avionics upgrade so that the whole fleet of our ski-equipped aircraft will be brought up to the standards of similar DOD aircraft so that for the pilots, the training and so forth, is similar across the DOD program and our pilots are not in any way forced to go to special training for running our aircraft.

IMPACT OF GRAMM-RUDMAN ON 1986 USAP PLAN

Mr. GREEN. The 1986 current plan of \$115,160,000 will have to be reduced under Gramm-Rudman by about \$4,949,000. From where are you going to take that money?

Dr. WILKNISS. With the intent of the Gramm-Rudman-Hollings Act, we have applied it across-the-board; so we will take the 4.3 cut in all of these programs. We have early-on informed the Navy and the Coast Guard and our contractors to budget in such a fashion that the budgets were prioritized looking forward to these cuts.

We issued a letter to the Navy in January which reached them when they were in the Antarctic. The Commander has returned and we will have a meeting. As a matter of fact, we have a meeting with him today to see where he will take the cut, which was difficult to do during the season when everybody is in Antarctica. The Coast Guard was reduced, as was our scientific research program. The science cut comes to about four or five grants that we have.

Mr. GREEN. Given the way the program operates, will that be affecting the program coming up next November, December and January?

Dr. WILKNISS. Yes, sir. I think it will. The program will have to tighten its belt and look very hard at where we might reduce. The highest costs, for instance, in the military are personnel. We have, in our letter to the Navy, written they should take a hard look at the personnel situation rather than the squadron that flies the helicopters and aircraft.

We have to look at other things which we have in the Antarctic, not what I would call frills, but where we might save money.

NEW ZEALAND NUCLEAR POLICY

Mr. GREEN. The Government of New Zealand continues to bar nuclear power ships or ships bearing nuclear weapons from its

waters. I presume it is still U.S. policy not to comment on what our ships may or may not be carrying.

Is the New Zealand Government considering any actions to make permanent this position, and to what extent does that affect the Antarctic program, specifically the operations staging activities that are carried out in Christchurch?

Dr. WILKNISS. Since we last testified before this Committee, things have gotten to a point where we have to be concerned. Prime Minister Lange's government has introduced legislation in the New Zealand Parliament to deny access to nuclear powered ships and to deny access to any craft that carries or may carry nuclear weapons.

What this means is that the Administration has a policy of non-confirmation and non-denial and that will mean that if Prime Minister Lange enforces this legislation, should it be passed, we have a situation that could bar our ships from New Zealand. Also our military aircraft, for instance, the so-called channel flights could be affected by that, too.

So this is a serious change since last year and I think a spokesman for the Administration has said the day that legislation is passed we will have to reevaluate our position with New Zealand as an ally.

I have tried to ascertain when the legislation will be passed and I have not been able to obtain a date. It is lingering in the Parliament.

1985 TESTIMONY

Mr. GREEN. Let me read some testimony from last year to see if you still feel the same way about it.

Mr. BOLAND. Will the recent problems concerning access to New Zealand ports for American naval ships have a spillover effect onto this program.

Dr. WILKNISS. I hope not, but it cannot be predicted with certainty. The position we have been trying to take in the Antarctic Policy Group points out to those in the government concerned with developing options for a new political stance for the United States in the South Pacific that the base in Christchurch, New Zealand is exclusively a logistic base for Antarctic operations.

This Antarctic support comes under the Antarctic Treaty system and the treaty system does not allow military operations so it should not be considered a military base.

Whereas, the Anzus Pact is concerned with military questions and totally separate. We hope we can keep this separation in the deliberations that take place concerning our policy in the South Pacific and New Zealand.

Mr. BOLAND. How large a base is that? What sort of personnel do we have at Christchurch?

Dr. WILKNISS. Depends on the time of the year, during the austral summer season we have 200 people in New Zealand. They are navy support personnel who help with the logistics and maintain the aircraft.

We do employ about 50 or 60 New Zealand civilian employees and we have a number of scientists traveling through there and some NSF personnel. During the winter it is on the order of 70 persons.

Mr. BOLAND. All right.

Dr. WILKNISS. That is, at that base only.

Mr. BOLAND. You are indicating that the problems we have had with New Zealand have not had an effect up to this point on the business we have there?

What about moving the base to Australia?

Dr. WILKNISS. That would be very costly as far as the United States is concerned. The Australians have their own base for Antarctic operations in Hobart, which is in Tasmania. It would add several hundred air miles in going to the Antarctic from

the base, and of course, it is not at this time as accessible and included in the global air lift cargo system and ship cargo system as New Zealand is.

Mr. BOLAND. Did that question ever arise in talking with the New Zealanders on the possibility of a move to Australia?

Dr. WILKNISS. There is great concern about it in the press and it has come up at the highest level. For instance, the Australian Prime Minister, Mr. Hawke, was asked on his return from his recent visit here to the President had this come up and he said that it had not come up and that Australia wasn't going to take advantage of its friends and propose such a thing to the United States.

There have been some statements attributed to U.S. personnel in New Zealand that that would be a possibility but to the best of my knowledge they are unfounded on any direction from Washington.

Mr. BOLAND. Is there any appreciable difference in distance between New Zealand and the Antarctic and Australia and the Antarctic?

Dr. WILKNISS. Yes, several hundred air miles to Tasmania and closer to five or seven hundred air miles from the mainland of Australia than it is from the south island at Christchurch.

RESPONSE TO 1985 TESTIMONY

Dr. WILKNISS. I fully stand behind this. From the viewpoint of the Antarctic program and the U.S. policy of support for the Antarctic Treaty system, I think the Administration's policy has not changed. We have to review it, but the base in Christchurch, which is our jumping off point for the Antarctic under the Antarctic Treaty System, and ANZUS are different matters.

All the other facts obtain that Australia is much further away. More statements have been in the press that we might move our base. There were several Congressional delegations this year in New Zealand and this came up in the highest discussions, but I stand on what I said last year, that there is no direction from the Administration nor plan at this time to move our base from Christchurch.

IMPACT OF PRIVATE EXPEDITIONS ON USAP

Mr. GREEN. Recently two private expeditions to the Antarctic were conducted. The first, the so-called Footsteps of Scott Expedition, ran into some serious trouble when its vessel was crushed by the heavy ice floe in the Ross Island area. I understand the Navy rescued all of the crew within an hour after receiving the first call for help.

The other expedition was sponsored by the international environmental group known as GREENPEACE. What impact do these private expeditions have on your program, especially when they get into problems, as they seem often to do?

Dr. WILKNISS. By way of background, U.S. policy concurred in by the National Security Council is that the U.S. Government does not offer support to private expeditions. There is one caveat. In case of life-threatening situations, we would attempt search and rescue and the U.S. personnel have adhered to that moral commitment.

So what happens if a private expedition gets in trouble? Number one, it has an immediate impact on the program. You divert your resources, aircraft, helicopters, personnel. It costs money. We can't plan in our budget for that.

Number two, you put your own personnel and your resources in jeopardy. Nothing in the Antarctic is easy. They might have to go

to places where we could lose a helicopter, airplane or have injury to or death of U.S. personnel.

Number three, my experience last season was that it can be extremely divisive and polarizing to our people. There are many young people down there that we have, outstanding people that identify either with the adventure aspect or political aspects of such expeditions. If we try to enforce Government policy, then between the military, the contractor and the other people you have a very divisive situation. That is very bad in the summer and it may be extremely dangerous in the winter when these communities are isolated and have to get along with each other and with the private expedition members.

There is also political pressure in the program because foreign governments may try, and have tried, to influence decisions here in Washington and in how we deal with these private expeditions.

Finally, we face litigation. All these expeditions ask for information. If we don't give it they might sue us. If we give it to them and it isn't right, and in Antarctica weather prediction and air traffic control are often difficult, you also get sued. For example, the U.S. District Court has agreed to hear the suit by the survivors of the crew members of the Air New Zealand DC-10 that crashed several years ago. They filed a suit against the U.S. Government here in District Court and I think it will be heard sometime this year.

DETERIORATION OF OZONE LAYER OVER ANTARCTICA

Mr. GREEN. It is my understanding that satellite observations of the earth have indicated an alarming and apparently progressive deterioration of the ozone layer above Antarctica. Has your research gotten involved in this?

Dr. WILKNISS. This discovery was made by the British in the Antarctic Peninsula. NASA has approached us and we have said we will render assistance for research this coming season, next fall, at the South Pole to study this phenomenon.

It occurs in the month of October from what we know now.

USAP SCIENTIFIC RETURN

Mr. GREEN. Mr. Bloch, looking at the Antarctic program as a whole, how would you characterize the current scientific return on these research dollars? Excellent, good, fair?

Mr. BLOCH. Well, if you just look at the cost of doing the research there you must tell yourselves that it is very expensive obviously because of the logistics aspects that Peter so well described.

On the other hand, it is about the only laboratory that has this kind of an environment built in. Therefore, we are stuck with the cost.

I think for what we are spending there in terms of research dollars we are getting a fair return, but it is not a cheap proposition and we need to understand that.

The second point I want to make is the circumstances in Antarctica are such we really have to focus on the facilities more than we have. The facilities run down very easily.

They deteriorate in this country, too, but we talk here about 20-year life cycles and in Antarctica you talk about less than that.

We have really to ask ourselves what our strategy will be over the next five to ten years with regard to facilities and also with regard to research. In fact, this year in 1986 and the remainder of 1986 and 1987, the National Science Board will take a good look at this particular problem. It is a concern.

Mr. GREEN. I guess to some degree the decision is a political one, as well as a scientific one.

Mr. BLOCH. That is correct. That is correct.

SCIENCE AND ENGINEERING EDUCATION

Mr. GREEN. If we could turn to the Science and Engineering Education Directorate where you are requesting \$89 million in 1987. We asked during the general questions how much you requested from OMB and I believe you said \$112 million.

If we added \$20 million to this account, and offset it by other reductions in other NSF areas, do you think we would get the most value for the buck if we targeted it into the teacher preparation and enhancement sub-activity?

Mr. SHAKHASHIRI. The area of teacher preparation and teacher enhancement is one with high leveraging effect and continues to be very popular in the field.

We received many good proposals we are unable to fund. The level that is currently in place seems to be effective and, as I indicated last year, this area is of special interest to the Foundation.

It is a high visibility area and that warrants more attention. We have targeted some subsets of that area and we are beginning to receive responses from the communities in that regard which are extremely favorable. I would say that with the level of support that we have now, we are able to support only about 12.5, 13 percent in that area.

There are some other areas where we do a little bit better than that.

Mr. GREEN. Mr. Bloch?

Mr. BLOCH. Yes. I wanted to comment on the general question of allocating additional funds at the expense of the rest of the Foundation's budget. That is a great concern to me because, as I mentioned before, this is a balanced budget. Obviously we would all like to see bigger numbers in all areas and in all disciplines.

That goes without saying. But reality is reality.

Secondly, we should realize that the National Science Foundation, while it has a mandate to be concerned with pre-college education, undergraduate education and graduate education, at best we can only be a small player.

If you look at the pre-college education, the country spends something like \$150 billion. Even if we double or triple the dollars that we are spending on it, it is a very, very small percentage.

Therefore, we can only attack our problems through leveraging, through examples, by demonstration, by making certain points which puts emphasis on certain areas. We are doing that and finding it works.

There is no way we can solve the total education problem of the country. We can only set examples. You can bring diverse commu-

nities together with our funding and I would think the dollars that we have allocated are doing that.

As far as adding twenty more million dollars to it or not, I don't think that would make much difference. It is much more important that we keep the stability of the program, that we do not get back into these on again, off again kind of situations that we have seen over the last few years, but have a constant policy for the Foundation.

So I would urge the Committee not to reallocate from the research area into this area. If additional monies can be found, by all means, but we should always realize that from a total dollar viewpoint, we are a small part of the total.

The thing we can do is provide excellence and provide focus and provide leverage, and we are trying to do that.

IMPACT OF 1986 GRAMM-RUDMAN ON SEE

Mr. BILL GREEN. The current level for 1986 before Gramm-Rudman sequestration was about \$27 million. Could you indicate for me in some detail, and provide in full detail for the record, how you are taking Gramm-Rudman for the SEE sub-activity?

Mr. SHAKHASHIRI. For that sub-activity, as Mrs. Toye indicated this morning, the \$27 million are made up of 1985 and 1986 funds. Only the 1986 funds are subject to Gramm-Rudman reductions and what we would have to do is look at the very big grants that we have and examine those very closely.

We also have been looking very carefully at those proposals still under consideration and subjecting them to appropriate reductions in order to meet the target of 4.3 percent of the 1986 funds.

Mr. Green, in this regard, I would like to say despite the fact that we are pleased that the 1985 funds are not subject to Gramm-Rudman reductions, I would have preferred to have the entire 1986 funding be different than it is and have it be subjected totally to 4.3 reduction, but that is a matter that is behind us.

But I just wanted to mention that despite the fact we are pleased the 1985 funds are protected, the preference obviously would have been to have a higher appropriation and to subject that to 4.3 percent reduction.

Mr. GREEN. If you will provide the full detail for the record.

Mr. SHAKHASHIRI. Yes.

[The information follows:]

SEE PROGRAMS

The FY 1986 budget authority for SEE programs is \$55.5 million which includes: \$11.5 million for Teacher Preparation and Enhancement; \$9.25 million for Materials Development, Research and Informal Science Education; \$2.0 million for the Office of Studies and Program Assessment; \$5.5 million for the Office of College Science Instruction; and \$27.3 million for Research Career Development. The \$31.5 million in deferred FY 85 funds are not subject to the Gramm-Rudman reduction of 4.3%. The distribution of the 4.3% reduction among SEE programs is as follows:

Program	Fiscal year appropriations	Reduction for Gramm-Rudman
Materials development, research and informal science.....	\$9,250,000	\$397,750

Program	Fiscal year appropriations	Reduction for Gramm-Rudman
Applications of advanced technologies	3,000,000	129,000
Instructional materials development	2,200,000	94,600
Informal science education	3,500,000	150,500
Research in teaching and learning	550,000	23,650
Teacher preparation and enhancement	11,500,000	494,500
Science and mathematics education networks	1,000,000	43,000
Teacher enhancement	7,500,000	322,500
Local and regional teacher development	3,200,000	137,600
Leadership activities for precollege teachers	4,300,000	184,900
Teacher preparation	2,000,000	86,000
Presidential awards	1,000,000	43,000
Office of Studies and Program Assessment	2,000,000	86,000
Studies and analyses	2,000,000	86,000
Office of College Science Instrumentation	5,500,000	236,500
College science instrumentation	5,500,000	236,500
Research career development	27,300,000	1,174,635
Graduate fellowships	24,570,000	1,057,245
Minority graduate fellowships	2,730,000	117,390
Total	55,550,000	2,389,385

LETTER FROM PRESIDENTIAL AWARD WINNER

Mr. GREEN. I would like to read a letter dated November 30, 1985, that Mr. Boland received from a Presidential award winner for excellence in teaching science:

Dear Mr. Boland: As the winner of the 1985 Presidential Award for Teaching Science in Wisconsin, may I express a few opinions on the importance of the continuing support of science education by Congress. You are surely aware of the shortage of science education majors in the colleges, but are you also aware that very few current science teachers are under 40? Many of them intend to retire from teaching within the next ten years and unless something is done to improve the supply of teachers, they will be replaced by people with very little preparation.

Of my students who have shown an interest in science, they have all gone into industry. Why not? After three or four years, they are all making more money than I do. I find it difficult to encourage my better students to exhibit the altruism necessary to enter teaching. For someone like me, it was easy because my husband had a good job and I could choose something I enjoyed. But I also enjoyed working in industry and I didn't have to take a hundred papers home to grade each night.

If we can't raise salaries, and that appears difficult today, then there must at least be something comparable to the N.S.F institutes of the past to help teachers upgrade their own education in science. I know how very valuable some of those were for me. Currently there are a few similar courses being put on in cooperation with industry, and they too are helpful, but can't begin to replace the broader scope of the N.S.F courses.

We all know the need for better education in science whether a student plans to major in science or simply needs enough background to make wise personal and political decisions that involve science. Please don't cut the budget in an area that needs help so desperately.

Thank you. Sincerely, Jean Lundquist.

She seems to feel that something comparable to the NSF institutes of the past are absolutely necessary if we are not going to raise teacher salaries or if we can't raise teacher salaries.

I know the Chairman found her letter very thoughtful, and while I suspect you don't necessarily agree with her advocacy of the institutes, what about it?

ON ADVOCACY OF NSF INSTITUTES

Mr. SHAKHASHIRI. I think she makes an excellent point. The summer institutes in the past have been very successful. Present programs now are targeted at the teachers and especially those teachers that require increased competency of the subject matters that they teach. We invest almost \$20 million every year in support of such activities.

In this regard, Mr. Green, I would like to point out the importance of the continued presence of the National Science Foundation in this area. As was mentioned earlier today, NSF has had an excellent track record in this regard and we are practically the only agency that has the responsibility to see that the future of science and the future of engineering is attended to.

I believe that the situation the country faces now is by far now much more critical and consequential than we faced in the immediate post-Sputnik era, for three reasons.

One, there are more of us in the country. The population in the past 25 years has increased by about 50 million people. To put that number in perspective, that is roughly the population of Great Britain alone.

So what does that mean? It means we have more students to teach and we need more qualified, and I want to underscore the word "qualified," more qualified teachers.

The letter that you talked about is not too different from a number of other letters that we have received.

The second reason why the situation now is more critical and more consequential is that this country must have a good supply of scientists and engineers in order to maintain our international preeminence. As Mr. Bloch so eloquently said this morning and on so many other occasions, in order to maintain our economic competitiveness this country must have the manpower to do that.

The third reason, and perhaps the most important of all three reasons, is that we now live in a more advanced technological society. It is this technology that our citizens need to be able to cope with and even do better than cope with, need to enjoy and derive some benefits from.

So the efforts of NSF and the presence of NSF in this area is extremely critical.

PROGRAM DEVELOPMENT AND MANAGEMENT

Mr. GREEN. Okay. Let's turn to program development and management. You are requesting a limitation of \$78 million and 1,174 FTE for program development and management in fiscal year 1987.

This is an increase of \$6,100,000 above 1986 after sequestration of \$3,117,500 and an approved reprogramming of \$2,517,500.

When Congress established the 1986 limitation on program development and management at \$72,500,000 in the 1986 HUD-Independent Agencies Appropriation Act, that amount was reduced by \$3,117,500 to \$69,382,500 due to sequestration. The Committee re-

cently approved a reprogramming request of \$2.5 million for PD&M. That makes the 1986 program development and management limitation \$71.9 million.

How will this affect the 1986 column in the justifications? That column shows a total of \$72.5 million.

From which will the reduction of \$600,000 be taken?

Ms. TOYE. The reduction will be taken entirely in other operating expenses in that line and within that, it comes from ADP. We have budgeted for the initial stages of an upgrading of the central computing capability and we have deferred that.

That funding constitutes the \$600,000.

Mr. GREEN. We discussed your full time equivalent level in 1986 and 1987. Could you provide for the record what FTE levels you will be able to support in 1986 and 1987? Also, revise the staffing table on page PDM-3 and reflect the FTE levels that can be supported in 1986 and 1987 for the record.

[The information follows:]

FTE LEVELS IN 1986 AND 1987

We are currently running at about 1115 FTE's. We could probably hire an equivalent 30 FTE's over the next six months and still be within our current personnel funding request, but that would be both irresponsible and almost impossible. Impossible because we would have to add on a net of 120 people over the next six months to equate to 30 FTE's, and irresponsible because that action would put us at an effective FTE rate of 1235 FTE's for 1987, for more than our request would permit.

Our intention is to reasonably and cautiously staff-up in 1986 so that we can stabilize our FTE level moving into 1987. We will probably use around 1130 FTE's in 1986, and would like to move into 1987 at an annualized FTE rate of about 1150. As we have demonstrated in response to an earlier question, we can fund this staffing level given a reasonable mix of grades and types of positions filled.

Based on PC&B available in 1986 and 1987, NSF can support the following FTE distribution:

	1986	1987
MPS.....	126	127
ENG.....	113	115
BBS.....	157	157
AAEO.....	160	165
STIA.....	149	145
SEE.....	62	63
AD/A.....	209	215
Staff office.....	175	175
Consultants.....	12	12
Total.....	1163	1174

We can support approximately 1163 FTE's in FY 1986. In 1987, we have used our targets as the level of FTE's that can be supported because relatively minor changes in the staffing mix could easily bring us up to the 1174 limitation. For example, we could lose 4 GS-15's at \$60,000 each and using the \$240,000 saved, hire 2 GS-13's 3 GS-12's, and 4 GS-7's. The net effect would be to raise our FTE count by 5 without spending additional money.

Mr. GREEN. On page PDM-5, you indicated an additional \$200,000 request in 1987 for full time permanent positions. Which program or programs will be increased in staffing in 1987?

Ms. TOYE. This \$200,000 item does not relate to any increase in staffing or any shifting in staffing in terms of organizational mode. Even when salaries are frozen as they are at this time, there is a \$200,000 item that creeps in every year in the form of merit pay adjustments.

There is a fraction of the merit pay increase that goes into effect even when salaries are frozen and for us that is close to \$200,000.

There is also an item there, I believe, \$89,000 that relates to some changes in the way the base is calculated for FICA taxes and for employee health benefits.

Mr. GREEN. In the justification paragraph immediately below the table, you indicate that the increase will permit higher FTE utilization within the 1,174 limitation, does it not?

Ms. TOYE. Yes, sir. Because if we don't get the \$200,000 that is expended in the merit pay, that leaves us \$200,000 short. That converts to a number—4 to 10 FTEs depending on salary—this is a real and demonstrable increase.

1985 COSTS FOR TELEPHONE, TELEGRAPH AND COMMUNICATIONS

Mr. GREEN. On page PDM-7, under rents and communications, you show \$2,661,722 obligated for telephone, telegraph and communications in 1985. Last year you estimated \$2,936,400 for the same items in 1985.

What enabled you to obligate \$274,678 less for the amount you had estimated?

Ms. TOYE. I am not used to explaining savings. Jeff, can you comment?

Mr. FENSTERMACHER. I don't have the details here; I could supply it for the record—but it depends on the rate reductions that have flowed from the AT&T breakup. I can give you the details for the record.

[The information follows:]

COMMUNICATIONS COSTS IN 1985

	Fiscal year 1985 estimate	Fiscal year 1985 actual	Difference	Explanation difference
Telephone.....	\$1,421,700	\$1,394,131	\$27,569	Two percent decrease due to overestimate of FTS charges for fiscal year 1985.
Telegraph/cable	105,800	68,466	37,334	Fiscal year 1985 estimate based on fiscal year 1984 actual plus inflation and on anticipated increase in traffic. During the year, traffic decreased instead.
Postage.....	1,368,900	1,187,182	181,718	Mail volume overestimated for Science and Engineering Education Directorate. Actual cost is based on postal sample and estimate is based on post office projection.
Computer terminals.....	40,000	11,943	28,057	Controller's Office (Budget Division) use of time-sharing for special reports. Increase capability of doing work in-house resulted in less use of outside time-sharing.
Total.....	\$2,936,400	\$2,661,722	\$274,678	

Mr. GREEN. You are requesting an increase \$1,028,300 for telephone services, including the initial investment for a PBX system.

Does that mean maintaining the current system would require a greater increase than \$1,028,300 and if not, could you explain?

Ms. TOYE. There are two pieces to that. One is that our current telephone system is an extremely antiquated one and we are going to have to give major attention to upgrading of that system for simple purposes of survival. Our interest in installing a PBX or some similar massive upgrading of the system also relates to our plans for data processing.

Our communication system simply is not adequate to handle the things that we hope to do in terms of upgrading our ADP capability.

In terms of the specific tradeoffs, I would like to provide those for the record.

[The information follows:]

A PBX SYSTEM

A PBX would be of substantial benefit to the Foundation in the area of ADP processes. Current and future requirements for providing data communications capabilities among the agency's computerized system could be incorporated into the functionality of the PBX. In addition, the integration of voice and data communications into a comprehensive information exchange system would more easily be obtained in a digital PBX environment.

From a savings standpoint, a telephone system feasibility study prepared for NSF by a consultant in April 1984 predicts savings over probable present system costs of \$4,304,181 over the first 5 years, \$2,679,140 over 7 years and \$4,941,066 over the 10-year period following installation of the system.

COST OF A PBX SYSTEM

Mr. GREEN. Do you have any estimates what the new PBX system would cost?

Ms. TOYE. We are using the round figure of \$2 million over two years and in our case there are complications. We share our building with the Secret Service, an arm of the Treasury, and there is a GSA regulation that says you can have only one PBX switch per building, so we are both pursuing our independent examination, and we are dealing with C&P to look at other options.

We are also dealing with Treasury Department to see if we can use their RFP and I think we have yet another negotiation with the General Services Administration about a government-wide system. So that is a rough estimate of \$2 million over two years, roughly in accord with the current cost of the system.

Mr. GREEN. What would happen if you didn't get the \$1,028,300 increase requested in 1987?

Ms. TOYE. We would simply have to make do. We are talking, as I say, with C&P at this time over some other possible options and trade-offs by altering the service and equipment that we have; that would give us some edge, but certainly short of doing a massive overhaul. We will have problems with our ADP plans if we don't overhaul.

Mr. GREEN. Can you absorb this cost from other activities?

Ms. TOYE. We would look at it. The problem that we have in PDM in general is fully two-thirds of our PDM line is payroll. We cannot move money from the personnel compensation and benefits into the other activities, so the flexible part of PDM budget is very small. To talk about absorbing a million dollar item into the \$17

million from which we pay the rent and all our other expenses—that kind of flexibility for million dollar items is very hard for us to squeeze out of that line.

Mr. BLOCH. If I may comment on that, Mr. Green.

I looked at this area very thoroughly when I came first to the Foundation. I convinced myself that over the years the Foundation has done very well keeping its overhead, or PDM costs, down to an appropriate level.

Secondly, in pushing on PDM and reducing a head count it was done with the understanding that we had to invest in work stations, a telephone system, and a better computer system.

We have been postponing these extensions over the years always because of tightness in the budget. I think the time is here when we have to step up to it. If we get another reduction, as we discussed a minute ago, I don't know what we can do, but I would like to preserve flexibility so that we can move in the right direction because we have to put these systems in place.

We have to put these work stations in place in order to stay productive and increase our productivity.

CONTRACTING OUT SERVICES

Mr. GREEN. You continue to contract out for certain administrative functions. On page PDM-8, in the third paragraph, you indicate that contracting out of mail and supply, copy room and warehouse/supply activities will require an increase in funding of \$430,000 in 1987. That amount is partially offset by a \$95,000 decrease under transportation of things due to the transfer of funding for the warehouse and supply center to administrative contracts.

Is it more expensive to contract out for these services?

Ms. TOYE. No. We have over the last two years contracted out that, plus health services—I think that is the one thing not mentioned in the question.

In every case, save one, we have done a very thorough cost analysis which has shown—and I can provide this in detail for the record—that the benefits are significant in these contracts. We wouldn't enter into them without that.

In the case of the health services, the rationale was a different one. The medical doctor who served there retired and I think they simply found it difficult to find someone willing to take on that sort of thing and went to a contract organization to provide that.

In all of the other cases it was a cost benefit analysis argument.

Mr. GREEN. If you will supply that for the record.

[The information follows:]

CONTRACT COSTS

Function	NSF Cost	Contract Cost Fiscal year—		Savings Fiscal year 1986
		1986	1987	
Mail.....	268,635			
Copy.....	120,601			
	289,236	165,890	*185,700	123,346
Supply.....	211,500			
Warehouse.....	188,996			

CONTRACT COSTS—Continued

Function	NSF Cost	Contract Cost Fiscal year—		Savings Fiscal year 1986
		1986	1987	
Health services.....	300,496	196,253	*216,00	104,243
	172,000	*200,000	*208,000	

¹ Small business contract

² Increase over fiscal year 1986 for 10 percent inflation.

³ Contract provided the only means of acquiring a physician's services; contracted through competitive bid process.

⁴ Increase over fiscal year 1986 for 4 percent inflation.

DATA PROCESSING

Mr. GREEN. On page PDM-9, you are requesting \$5,725,000 for data processing activities in 1987. If Congress provides data processing funding at that level for 1987, what do you estimate will be the data processing costs in 1988 and 1989?

Ms. McLINDON. It looks as though the 1988 and 1989 budgets would be fairly stable in terms of 1987 figures. The biggest item in the 1987 budget is the acquisition of larger computer power which does involve out-year commitments, but they will be offset by a reduction in distributed systems cost.

Mr. GREEN. Would that be five million a year, though?

Ms. McLINDON. Probably about five million because we actually are going down in terms of acquiring distributed systems, and I think there is a statement in the budget book that indicates that the workstation and networking costs will go down. The acquisition of larger computing power would represent an increase but they would basically balance each other out. I think the level would be around 5.5 for the out years.

SALARY INCREASES

Mr. GREEN. The NSF has greatly increased its average GS salary. The table on PDM-13 shows the average GS salary in 1985 to be \$39,236. That is \$5,423 above last year's estimated average salary of \$33,813. The current 1986 estimated average salary is \$8,217 above last year's 1986 estimate.

Obviously the more salary per person, the fewer staff you can have, if the funding remains the same. What is driving these increases?

Ms. TOYE. Several forces are driving them. The basic one in this case is arithmetic.

As we discussed earlier in the day, we were in a situation last year where we went into a protracted hard freeze across the Foundation which results always in greater attrition in low paid people.

This was aggravated, I must say for very positive reasons, in that the hires we did make were the Presidential appointees you see sitting at the table, plus a very major effort to staff our three high priority areas, Science and Engineering Education, the Advanced Scientific Computing effort and the Engineering Directorate.

So the people who we were hiring in that period were very expensive people and we have been struggling since to regain balance. We have a system in place, by the way, where we scrutinize

the entire payroll every two weeks and redo a projection model to the end of the year. I will be more than happy to share those on a monthly basis.

We build in every accession, every within grade increase and right now we are running about a million dollars below our salary account. That reflects Gramm-Rudman. We did not put on a formal freeze, but until we knew where we were in terms of Gramm-Rudman, essentially we have frozen most of our hiring for the last three months.

Right now we have a million dollars in the salary account. Looking at what is in the pipeline, we see lots of technical, relatively low grade, grades 7, 8, 9, 11 technicians and para-professional people.

Mr. GREEN. Aren't the Presidential employees executive salaries SES, rather than GS?

Ms. TOYE. Yes, but that is a cap: \$68,700—you see those are average salaries. We are talking about average salaries.

Mr. GREEN. But that wouldn't show up in the GS line of \$39,236.

Ms. TOYE. No, but virtually all of the program managers whom we hired in engineering, science education, are GS-14, 15. That is the typical grade level; that is where we put most of our increases.

COLLECTING OUTSTANDING DEBTS

Mr. GREEN. Turning to another question; on December 31, 1984, the total amount of debt outstanding was \$162,642. Of that amount, two institutions owed over \$120,000. Both those cases have been referred to the Department of Justice.

Has Justice made any final determination as to whether or not these debts are in whole or part collectible?

Ms. TOYE. They are still with the Justice Department. At this time they haven't been adjudicated. I can supply for the record the outcome.

I think the sum total, if I may, was \$162,000 for all of the outstanding debt.

Mr. GREEN. These two owed about \$120,000.

Ms. TOYE. The two together, yes.

Mr. GREEN. What was the amount of debt outstanding at the end of 1985?

Ms. TOYE. It looks to me like about \$17,100-some dollars.

Mr. GREEN. For the record, if you could update the table that appears on pages 220 and 221 of last year's hearings.

[The information follows:]

NATIONAL SCIENCE FOUNDATION BAD DEBTS GRANT ACCOUNTS RECEIVABLE

	As of Dec. 31, 1984	As of Dec. 31, 1985
Daniel Payne College.....	\$67,676.19	\$67,676.19
Legis. 50/Ctr. Leg. Improve.....	5,103.00	5,103.00
Holosonics, Inc.....	16,921.32	16,921.32
Ministerial Inst. & Col.....	53,695.00	53,696.00
University of Berne.....	0	1,607.00
Beers Associates.....	0	5,405.00
Maine State Legislature.....	0	9,339.18

NATIONAL SCIENCE FOUNDATION BAD DEBTS GRANT ACCOUNTS RECEIVABLE—Continued

	As of Dec. 31, 1984	As of Dec. 31, 1985
Pacific NW Innovation Group	19, 246.80	21,044.61
Totals	\$162,642.31	\$180,791.30

¹ Bankrupt.² Referred to Justice Department.³ New claims added during the year.⁴ Referred to U.S. Attorney, Washington State.

Changes During Fiscal Year 1985

	Number of Accounts	Amounts
Grant account receivables—12/31/84.....	5	\$162,642.31
Collections.....	—0	0
New claims.....	+3	+18,148.99
Grant Account receivables—12/31/85.....	8	\$180,791.30

NSF DETAILEES AT OSTP

Mr. GREEN. For a number of years, NSF has detailed individuals to OSTP. OSTP has reimbursed NSF for some of the detailees. How many individuals did NSF detail to OSTP in 1985?

Ms. TOYE. We had seven. In my tenure, we had seven at the end of 1985. It is now down to five.

Mr. GREEN. What was the cost of the individual detailees to OSTP in 1985?

Ms. TOYE. I will have to give you that for the record.

The current group is running at about \$200,000 annualized. I would suppose it was about a quarter of a million. I will have to provide that.

Mr. GREEN. If you could also tell us how much OSTP reimbursed NSF for the individuals detailed in 1985. Has NSF detailed any individuals to OSTP for more than one year?

Ms. TOYE. Yes.

Mr. GREEN. How many individuals have been so detailed and for how long? That can be supplied for the record.

Ms. TOYE. We will have to provide that for the record. I know some but not all.

[The information follows:]

1985 NSF STAFF AT OSTP

During FY 1985, thirteen individuals were detailed to OSTP for varying periods of time, utilizing approximately eight FTE's. Total personnel compensation and benefits costs were \$341,146 for which the Foundation was reimbursed \$339,830. During FY 1985 seven of the thirteen individuals were detailed for a year or longer. Of the current five detailees, four were on detail during FY 1985.

INCREASING TEACHER PREPARATION AND ENHANCEMENT

Mr. BOLAND [presiding]. Thank you very much, Bill.

Let me ask one question with reference to science education. I am sure you will have the answer to it.

I may not agree with it but if we added \$20 million to this account, and offset it by reductions in other areas of the Foundation, do you think we would get the most bang for the buck if we targeted the money in the teacher preparation and enhancement sub-activity?

Mr. BLOCH. That was a question that was just asked.

Mr. BOLAND. What did he say? I wasn't here.

Mr. GREEN. Maybe it would be worth repeating the answer. The place to put it seems to be teacher education.

Mr. BOLAND. That is the place to put it. But the question is if we took the \$20 million from some other area, and target it for this particular activity, would you get more bang for the buck as a result?

Mr. BLOCH. No. I answered that question before.

Mr. BOLAND. We would have to take money out of some other activity as we understand.

Mr. BLOCH. As I mentioned this morning a couple of times and I mentioned it when this question came up a few minutes ago, this is a very precariously balanced budget. We did not get all the dollars that we wanted, as you know very well.

We made the compromises that we have to make and I think all areas have been treated very fairly. I would not want to take money out of the research and related areas, for example, \$20 million worth, and put them in science education because I think that would destroy some of the balance we have been trying to put in place.

We are deficient in a number of areas and not just in education. I would really urge the committee not to take money away from one area and put it into the other area.

Mr. BOLAND. I think probably the Committee ought to have some sort of an opinion on this and perhaps some advice, too; perhaps we should also have some input into it. It is an area that we think needs some sort of enhancement. Reducing other areas by 20 million and putting it into teacher preparation and enhancement wouldn't impact too much upon R&D, I wouldn't think.

Mr. BLOCH. It impacts it by 20 million dollars.

Mr. BOLAND. Yes, but out of a billion dollars that is a small percentage.

MESHING RESEARCH AND EDUCATION

Mr. BLOCH. A billion dollars, as you know very well and as we have discussed today, is spread into many different areas. It touches many different disciplines.

College education certainly is touched by research in many different ways, at the undergraduate level, at the post-doctoral level, at the graduate level, on and on.

How much money we are spending on education, you know, in total, is an untold story and it is really difficult to pull it together.

Mr. BOLAND. But it is not an untold story in the Foundation, though it may be it you talk about education generally.

Mr. BLOCH. Certainly here it is also because if you look at our grant dollar there is a lot in there for education that we are not

segregating at all. How many undergraduate students do we support? How many graduate students do we support? How much education do we support as part of the research activity?

The United States is in a unique and a very good situation combining research and education, except when you come to try to account for it.

Education and research is very tightly intertwined and one cannot separate the two. That is the strength of the system. So my point is we are spending many more dollars on education than what we have identified in education directorate, especially in the undergraduate and graduate areas.

FAIRNESS WITHIN CONTEXT OF THE BUDGET ENVIRONMENT

Mr. BOLAND. I don't think we are going to look at a budget that this Committee handles, and some are quite large, that has, even after the impact of Gramm-Rudman-Hollings, an increase of \$227 million. That is a substantial increase.

What is it? That is over a fourteen percent increase in research and related activities after the impact of Gramm-Rudman. I don't think we are going to find that in any other budget we have here.

As you know, this is one of the Committee's favorite agencies, and it is one of the ones we have dealt with fairly over the years.

I keep on saying that I am probably the only member in Congress that has sat here long enough to see the NSF budgeting over a billion dollars. I guess when NSF first started 30-some-odd years ago, you started with a budget of about \$250,000.

Now because we are concerned, and that concern is not only expressed by members who serve on this Committee, but by members who serve other Committees and by people who are in this field, science and education. It is an area, I think, that there ought to be a little revenue enhancement for, as somebody says on the other side of the Capitol.

You wouldn't mind doing that. I know it is not acceptable to you but you are an excellent director, and we have great rapport and communication with you.

On this one here we are kind of falling apart, though.

Mr. BLOCH. I don't think we are falling apart.

Mr. BOLAND. We are not falling apart but be prepared.

Mr. BLOCH. If you are telling me that you will fund our total request, and you will reallocate the \$20 million I probably won't scream very hard.

Mr. BOLAND. This committee handles about \$7 billion in budget authority or what have you, and we have some big problems this year.

NASA presents a particularly significant problem to us. So does the Department of Housing and Urban Development, where there have been some actions taken by the Administration with which I personally don't agree. I hope we can turn it around.

But it is a big bill and I know we get criticized for not funding some of the programs that some of the Members want. We can develop an issue out of it, but I don't look for an issue, I look for a bill.

We get it signed, incidentally, by the President because we go to conference, we come to an agreement on the other side of the Capitol and so we are fortunate. If we had somebody else sitting here besides Bill Green and myself, they would be asking for a hundred million dollars and we are only asking for \$20 million in this area.

Mr. BLOCH. Let me say one thing, Mr. Chairman.

First of all, we appreciate the support that we have received from you personally, from Mr. Green, and from the committee as a whole. Without it we wouldn't be where we are.

I also wanted to say that, yes, the Foundation has been treated very well over the years. I hope we justified that treatment and I know that you understand and realize that we have taken on increased responsibilities in many areas.

The science and engineering area is growing rapidly in the country and the dependence on it is increasing. I hope you take that into consideration. I want to thank you for your consideration.

Mr. BOLAND. Okay. Well, we have come to the end of a very pleasant hearing as it always is here. I always like it because we are close to you. We know whether or not we are getting a straight answer from you from the nods of the heads and the eyes of the people behind you.

Questions Submitted for the Record by Representative Jerry Lewis

Last year the Subcommittee learned that over \$70 million dollars has been donated by the Keck Foundation to Cal Tech University for the construction of a 10-meter multi-mirror telescope. At the time, the subcommittee questioned the need for NSF's continued support of a National New Technology Telescope (NNTT) in light of the telescope now being constructed for Cal Tech, in addition to other efforts both here and abroad.

Question. Dr. Bridgewater responded at the time that NSF would study just that issue. As we continue our deliberations over the FY 1987 budget for the Foundation, the Subcommittee would be interested to know just what NSF has learned since last year's testimony about the need (if any) for such a telescope in light of the Considerable involvement by the private sector in this area. Would you please comment?

Answer. It is important to emphasize that the Foundation has supported a *technology development program* over the past several years, and not the construction of a National New Technology Telescope. The results of one segment of the that program were instrumental in determining the final design of the Keck Telescope. Investigation of new techniques for casting lightweight mirrors under this program promises to revolutionize the design of large telescopes. While National Optical Astronomy Observatories are considering preliminary designs for a national telescope of 15-meter aperture, there is not yet a proposal before the Foundation for such an instrument.

As Dr. Bridgewater indicated to the Subcommittee last year, the Foundation has undertaken an extensive examination of the relationships among the Keck Telescope, various other efforts both here and abroad, and the Foundation's activities in the area of technology development for large optical/infrared telescopes. A subcommittee of the Advisory Committee for Astronomical Sciences was formed to consider the issue, and will present its report to the Advisory Committee this spring.

Question. How much is being proposed for NNTT for the current fiscal year? How much has been expended by NSF since this project was first undertaken?

Answer. The Foundation budget for Fiscal Year 1987 includes \$2.2M in support of technology development for large optical/infrared telescopes. Of this amount, approximately \$1.0M is for investigations of techniques to cast large (7.5 meter diameter) primary mirrors. The balance supports research into mirror support mechanisms, thermal control techniques, alignment and other structural problems, and minimizing the influence of telescope structures on the natural atmospheric conditions.

Funding for the technology development program began in FY 1981. The funding history has been:

[In thousands of dollars]

Fiscal year	
1981	\$466
1982	568
1983	1,091
1984	2,088
1985	2,192
1986 (estimated)	2,000

National Science Foundation
Washington, D.C. 20550

FY 1987

Budget Summary

New Obligational Authority:

FY 1987 Budget Request	\$1,685,700,000
FY 1986 Appropriation (P.L. 99-160)	1,523,855,000
Increase in New-Obligational Authority	161,845,000

Program Level:

FY 1987 Budget Request	1,685,700,000
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FY 1986:

Appropriation (P.L. 99-160)	1,523,855,000
Plus FY 1985 Deferral	31,450,000
Plus FY 1985 Carryover	302,878

FY 1986 Program Level	1,555,607,878
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Increase in Program Level FY 1987/1986	130,092,122
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**NATIONAL SCIENCE FOUNDATION
FY 1987 BUDGET TO THE CONGRESS**

TABLE OF CONTENTS

Budget Summary

Summary of FY 1987 Budget by Appropriation and Program.....	i
NSF FY 1987 Budget Request	NSF- 1
Special Emphases for FY 1987.....	NSF- 3
Activity Summaries.....	NSF- 7
Explanation of Prior Year Carryover.....	NSF-14
Budget Summary of Obligations by Activity and Subactivity Showing Dollar and Percentage Changes.....	NSF-15
Summary Budget Information by Subactivity, Activity, and Appropriation.....	NSF-16
Mathematical and Physical Sciences.....	NSF-17
Engineering.....	NSF-18
Biological, Behavioral, and Social Sciences.....	NSF-19
Astronomical, Atmospheric, Earth, and Ocean Sciences.....	NSF-20
Scientific, Technological, and International Affairs.....	NSF-22
Advanced Scientific Computing.....	NSF-22
Program Development and Management.....	NSF-22
U.S. Antarctic Program.....	NSF-23
Science and Engineering Education.....	NSF-23
Analysis of Changes in Obligation Levels.....	NSF-24
Percentage Distribution of Total Obligations.....	NSF-26
Summary of Obligations by Object Class.....	NSF-27
NSF Appropriation Language.....	NSF-28

Gramm-Rudman-Hollings Impact..... GRH- 1

Mathematical and Physical Sciences.....

Mathematical Sciences.....	MPS- 1
Computer Research.....	MPS - I - 1
Physics.....	MPS -II - 1
Chemistry.....	MPS - III - 1
Materials Research.....	MPS - IV - 1
	MPS - V - 1

Engineering.....

Chemical, Biochemical and Thermal Engineering.....	ENG- 1
Mechanics, Structures and Materials Engineering.....	ENG - I - 1
Electrical, Communications and Systems Engineering.....	ENG - II - 1
Design, Manufacturing, and Computer Engineering.....	ENG -III - 1
Emerging and Critical Engineering Systems.....	ENV -IV - 1
Cross-Disciplinary Research.....	ENG - V - 1
	ENG - VI - 1

NATIONAL SCIENCE FOUNDATION
FY 1987 BUDGET TO THE CONGRESS

TABLE OF CONTENTS, continued

<u>Biological, Behavioral, and Social Sciences</u>	BBS- 1
Molecular Biosciences.....	BBS - I - 1
Cellular Biosciences.....	BBS - II - 1
Biotic Systems and Resources.....	BBS - III - 1
Behavioral and Neural Sciences.....	BBS - IV - 1
Social and Economic Science.....	BBS - V - 1
Information Science and Technology.....	BBS - VI - 1
<u>Astronomical, Atmospheric, Earth, and Ocean Sciences</u>	AAEO- 1
Astronomical Sciences.....	AAEO - I - 1
Atmospheric Sciences.....	AAEO - II - 1
Earth Sciences.....	AAEO - III - 1
Ocean Sciences.....	AAEO - IV - 1
Arctic Research Program.....	AAEO - V - 1
<u>Scientific, Technological, and International Affairs</u>	STIA- 1
Industrial Science and Technological Innovation.....	STIA - I - 1
International Cooperative Scientific Activities.....	STIA - II - 1
Policy Research and Analysis.....	STIA - III - 1
Science Resources Studies.....	STIA - IV - 1
Research Initiation and Improvement.....	STIA - V - 1
<u>Advanced Scientific Computing</u>	ASC- 1
<u>Program Development and Management</u>	PDM- 1
<u>U.S. Antarctic Program</u>	USAP- 1
U.S. Antarctic Research Program.....	USAP - I - 1
Operations Support Program.....	USAP - II - 1
<u>Science and Engineering Education</u>	SEE- 1
Research Career Development.....	SEE - I - 1
Materials Development, Research and Informal Science Education.....	SEE - II - 1
Teacher Preparation and Enhancement.....	SEE - III - 1
Studies and Program Assessment.....	SEE - IV - 1
College Science Instrumentation.....	SEE - V - 1
<u>Special Foreign Currency</u>	SFC- 1
<u>Cross-Directorate Programs</u>	CDP-1
<u>Quantitative Data Tables</u>	
<u>Appendix A - Grants and Contracts Awarded in FY 1985</u>	

SUMMARY OF FY 1987 BUDGET BY APPROPRIATION AND PROGRAM

	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
RESEARCH AND RELATED ACTIVITIES					
Mathematical and Physical Sciences...	\$397,188,087	\$428,970,000	\$409,970,000	\$449,250,000	\$39,280,000
Engineering.....	150,628,125	170,070,000	162,475,000	185,470,000	22,995,000
Biological, Behavioral, and Social Sciences.....	253,510,645	272,050,000	260,070,000	282,410,000	22,340,000
Astronomical, Atmospheric, Earth, and Ocean Sciences.....	353,026,753	372,170,000	362,596,968	383,210,000	20,613,032
Scientific, Technological, and International Affairs.....	43,743,769	38,360,000	39,560,000	47,030,000	7,470,000
Advanced Scientific Computing.....	41,395,653	46,230,000	45,230,000	53,630,000	8,400,000
Program Development and Management..	71,951,270	69,900,000	72,500,000	78,000,000	5,500,000
Subtotal, Obligations.....	1,911,466,380	1,997,750,000	1,932,401,968	1,479,000,000	126,598,032
Unobligated Balance Available					
Start of Year.....	-2,053,249	-0-	-196,968	-0-	196,968
Appropriation Transfer.....	-5,000,000	-0-	-0-	-0-	-0-
Unobligated Balance Available					
End of Year.....	196,968	-0-	-0-	-0-	-0-
Adjustments to Prior Year Accounts..	-3,638,202	-0-	-0-	-0-	-0-
Unobligated Balance Lapsing.....	62,183	-0-	-0-	-0-	-0-
Research and Related Activities Appropriation.....	1,901,012,000	1,997,750,000	1,932,205,000	1,479,000,000	126,795,000
U.S. ANTARCTIC PROGRAM ACTIVITIES					
U.S. Antarctic Research Program.....	11,135,519	11,500,000	11,500,000	12,000,000	500,000
Operations Support.....	99,685,066	108,600,000	103,659,168	105,000,000	1,340,832
Subtotal, Obligations.....	110,840,585	120,100,000	115,159,168	117,000,000	1,840,832
Unobligated Balance Available					
Start of Year.....	-68,296	-0-	-59,168	-0-	59,168
Unobligated Balance Available					
End of Year.....	59,168	-0-	-0-	-0-	-0-
Adjustments to Prior Year Accounts..	-1,457	-0-	-0-	-0-	-0-
U.S. Antarctic Activities Appropriation.....	110,830,000	120,100,000	115,100,000	117,000,000	1,900,000
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES					
Research Career Development.....	27,297,922	27,300,000	27,344,325	27,300,000	-44,325
Materials Development, Research and Informal Science Education...	22,725,418	23,700,000	25,000,000	25,000,000	-0-
Teacher Preparation and Enhancement..	25,188,387	24,000,000	27,000,000	27,000,000	-0-
Studies and Program Assessment.....	1,747,713	2,000,000	2,200,000	2,200,000	-0-
College Science Instrumentation.....	4,996,379	5,000,000	5,500,000	7,500,000	2,000,000
Subtotal, Obligations.....	81,955,819	82,000,000	87,044,325	89,000,000	1,955,675
Unobligated Balance Available					
Start of Year.....	-31,450,278	-31,450,278	-31,494,325	-0-	31,494,325
Appropriation Transfer.....	5,000,000	-0-	-0-	-0-	-0-
Unobligated Balance Available					
End of Year.....	31,494,325	-0-	-0-	-0-	-0-
Adjustments to Prior Year Accounts..	-37,353	-0-	-0-	-0-	-0-
Unobligated Balance Lapsing.....	37,487	-0-	-0-	-0-	-0-
Science and Engineering Education Activities Appropriation.....	87,000,000	80,549,722	85,550,000	89,000,000	33,450,000
SPECIAL FOREIGN CURRENCY					
Special Foreign Currency.....	2,829,505	1,000,000	1,002,417	700,000	-302,417
Unobligated Balance Available					
Start of Year.....	-37,457	-0-	-2,417	-0-	2,417
Unobligated Balance Available					
End of Year.....	2,417	-0-	-0-	-0-	-0-
Adjustments to Prior Year Accounts..	-21,798	-0-	-0-	-0-	-0-
Unobligated Balance Lapsing.....	27,333	-0-	-0-	-0-	-0-
Special Foreign Currency Appropriation.....	2,800,000	1,000,000	1,000,000	700,000	-300,000
TOTAL, NET APPROPRIATIONS.....	\$1,501,442,000	\$1,569,399,722	\$1,523,855,000	\$1,485,700,000	\$161,845,000

NSF FY 1987 BUDGET REQUEST

The National Science Foundation (NSF) Budget Request for FY 1987 is \$1.7 billion, an increase of \$130 million, or 8 percent over the FY 1986 Current Plan. The total includes the following appropriations:

(Dollars in Millions)				
	FY 1986 CURRENT PLAN	FY 1987 REQUEST	INCREASE 86/87	PERCENT INCREASE
RESEARCH & RELATED ACTIVITIES	\$1,352.4	\$1,479.0	\$126.6	9.40
U.S. ANTARCTIC PROGRAM	\$115.2	\$117.0	\$1.8	1.60
SCIENCE & ENGINEERING EDUCATION	\$87.0	\$89.0	\$2.0	2.30
SPECIAL FOREIGN CURRENCY	\$1.0	\$0.7	(\$0.3)	-30.00
TOTAL	\$1,555.6	\$1,685.7	\$130.1	8.40

In a year of deficit reductions and a continuation of the Congressionally-mandated budget balancing strategy, the President's budget for the National Science Foundation shows a moderate increase. This is a continuation of support by this Administration for increasing civilian basic science and engineering research and education.

Science and engineering research and education provide the foundation for present and future economic competitiveness. They contribute to products that improve the lives of all citizens and help to guarantee our national defense. Investing in these activities is investing in the future well-being of our country. It is for these reasons that the President's Budget Request for Fiscal Year 1987 gives high priority to support for the National Science Foundation, as it has each year since FY 1984.

Although the NSF budget is a small fraction of the total national effort in research and development (about 3 percent), it is the primary source of support for fundamental science and engineering research and education in U.S. colleges and universities. This community is the principal performer of basic research in the physical and natural sciences that undergirds the entire R&D enterprise, governmental and private alike. The Nation's academic institutions provide the training ground for most of the scientists and engineers who staff our industrial, academic, and military laboratories. The President's request reflects his determination to preserve the Nation's leadership in basic research and to ensure our long range economic health.

In developing the Budget Request for FY 1987, highest priority is given to activities that contribute to national economic competitiveness and innovation, improve the physical plant and tools needed for research, develop the science and engineering personnel of the future, and recognize areas of exceptional scientific promise.

The Foundation's budget strategy for Fiscal Year 1987 provides for both continuity and change in the face of limited resources:

- o It provides continuity by maintaining balanced support for research of proven quality across all the disciplines;
- o It ensures change by investing significant resources in a small number of areas that offer particular promise for scientific and engineering advancement; and
- o It stresses fiscal responsibility by leveraging Federal investments wherever possible and by phasing down or terminating activities of lower priority or lesser promise.

National Economic Competitiveness. In 1987, NSF will expand the Engineering Research Centers program initiated in FY 1985; provide enhanced support for research in selected fields with high potential for long-term economic payoff such as materials, chemistry, computer science and biotechnology-related activities; and encourage innovation through support of research conducted by small businesses and joint industry-university research ventures.

Improving the Physical Infrastructure and Research Instrumentation. In recent years, we have reduced or rescheduled several major capital investments in research facilities. Although we consider this a necessary and appropriate response to financial constraints, it does not constitute an acceptable long-term policy for research support. By its nature, modern research requires state-of-the-art instruments and facilities. Accordingly, we have included items in the FY 1987 budget for increased investment in discipline-specific instrumentation programs and in the instructional instrumentation program in Science and Engineering Education. We will continue to invest in national supercomputing facilities and in the specialized facilities required for research in physics, materials science, astronomy, and the geosciences.

Science and Engineering Personnel. The human resource pool that will provide the scientists and engineers of the future is critically important. Some of these young men and women are already in the career pipeline. For them, NSF provides support for the initiation of individual research programs at colleges and universities, for postdoctoral opportunities, and for graduate research assistantships and fellowships. At the undergraduate level, and particularly the precollegiate years, where career decisions are not yet firm, the Foundation directs special efforts toward making scientific and technical careers attractive and attainable.

Significant enhancement of the undergraduate research effort is proposed for FY 1987 across the activities of the Foundation. Support for undergraduate instructional instrumentation, faculty research development, and the participation of undergraduate students in research activities will be emphasized. Support for the conduct of research at predominantly undergraduate institutions is also enhanced.

To complement and extend the targeted programs for increasing minority participation in science and engineering, a new program of Minority Research Centers of Excellence will be initiated in the Scientific, Technological and International Affairs Activity. This new program will identify a small number of minority institutions that have strong programs in

science or engineering and assist them in becoming centers of excellence. These centers will conduct research, provide graduate training, work with associated undergraduate institutions, establish strong ties with nearby precollege teachers and schools, and serve as community resources for stimulating minority young people to consider careers in science and engineering.

Leveraging Federal Dollars. NSF continues in FY 1987, as in previous years, to leverage Federal dollars by requiring the participation in certain programs of the private sector, State governments, and other non-public sources of support. NSF also operates a program that elicits special manufacturer discounts for equipment, instrumentation, and computers for use in the research and education programs of its grantees. Examples of success in leveraging NSF grant funds are particularly evident in the Engineering Research Centers, the Advanced Scientific Computing Centers, the Industry/University Cooperative Research Centers and the College Science Instrumentation Program.

Areas of Extraordinary Scientific Opportunity. For FY 1987, NSF has identified three areas that are uniquely poised for important advances:

- o Biotechnology,
- o Computational science and engineering, and
- o Global geosciences.

These areas are characterized by their multidisciplinary nature which demands collaborative efforts and their requirement for sophisticated equipment. They are areas where additional funding can have a large multiplier effect by establishing new institutional arrangements and capabilities for encouraging the collaboration that will accelerate and intensify scientific productivity.

SPECIAL EMPHASES FOR FY 1987

Biotechnology

The commercialization of biotechnology in the U.S. relies heavily on the fundamental research base. Future advances require scientists and engineers with multidisciplinary training and skills, and research environments that encourage multidisciplinary efforts. The chemistry of life processes effort and the Engineering Research Center in biotechnology process engineering at MIT are current examples of the NSF leadership role in establishing multidisciplinary research teams to work in this challenging area.

Currently, research in biotechnology is carried out in the Biological, Behavioral and Social Sciences, Engineering, and Mathematical and Physical Sciences Activities. For FY 1987, an increment of \$20.0 million will be added to the \$86.5 million provided in FY 1986 largely for individual investigator awards.

Three approaches will characterize the emphasis: centers, "mini-centers," and individual awards. Two to four centers for multidisciplinary research related to biotechnology will be established. Center awards would provide funds to modify or establish and equip multidisciplinary biotechnology laboratories, support existing centers with unique capabilities, and sustain the long term operation of these sophisticated facilities. They would also be

designed to leverage the investments of industry, universities themselves, and other government entities in research facilities. One such center, for example, might focus on biomimetic chemistry, which studies the synthesis of model chemical structures which mimic selected properties of real biological systems. Biomimetic chemistry involves organic chemists, physical chemists, biophysicists and biochemists.

Second, smaller cross-disciplinary groups and individual departments will be supported by "mini-center" awards. Mini-centers would provide the expensive multi-user instrumentation required for contemporary forefront work in molecular biology and biochemistry. In some problem-oriented areas, such as bioreactor design, stability of engineered proteins, and cell adhesion, awards would be a combination of instrumentation and research support.

Lastly, cross-disciplinary research and training programs will be expanded. Training has been a central focus of NSF support in biotechnology-related research for the past several years and will remain a high priority. For example, the need for scientists cross-trained as ecologists and molecular biologists has been highlighted repeatedly in recent Congressional hearings on biotechnology and biotechnology regulation.

Computational Science and Engineering

The Computational Science and Engineering (CSE) emphasis responds to a major opportunity in scientific and engineering research and advanced education. CSE research is currently supported in all of the research Activities at approximately \$57 million. In FY 1987, an additional \$27 million is requested to establish new multidisciplinary teams, enhance existing centers and groups, and provide equipment and training opportunities.

Advanced research in many areas of science and engineering increasingly relies on computational methods in addition to the traditional experimental and theoretical approaches. Examples of the power of this integrated approach are simulation of large-scale experiments that are impossible or prohibitively costly to carry out in the laboratory, and execution of the entire design and testing of a complex new process or product entirely on the computer.

Until recently, the U.S. academic research community had limited opportunity to use this powerful approach. Their access to the most advanced computers was severely restricted until the 1985 NSF initiative in advanced scientific computing made this tool more widely available to academic researchers. However, most NSF-supported CSE research is still performed by individual scientists and engineers without the benefit of collaboration with mathematicians and computer scientists.

NSF's CSE emphasis is intended to complement and extend these activities by providing support for computational science and engineering broadly across all research disciplines in academic institutions, with emphasis on collaborative, multidisciplinary approaches.

The purpose of the effort is to accelerate use of computational methods by all researchers and to integrate this into the overall scientific and engineering enterprise. Therefore, nearly all of NSF's disciplinary research programs will participate in the CSE effort. Emphasis is on formation of multidisciplinary research groups that bring together the component disciplines and capabilities to create an integrated activity. Some of these groups are expected to operate independently, while others may be attached to existing centers of major research activity, and still others may augment the capabilities of NSF's Advanced Scientific Computing Centers. Equipment will also be provided, both for new projects and to augment existing research projects and groups.

Global Geosciences

The FY 1987 Budget Request seeks an increase of \$18 million for increased emphasis on global geoscience through a series of interrelated research efforts treating the earth as an integrated system of physical, chemical, and biological processes. The estimated FY 1986 base is approximately \$17 million. The research emphasis will involve most of the subactivities of the Astronomical, Atmospheric, Earth and Ocean Sciences Activity, and the Biotic Systems and Resources subactivity of the Biological, Behavioral and Social Sciences Activity.

The interrelatedness of the atmosphere, oceans, biosphere, and solid earth is now well recognized and the field is ripe for major advances. Recent technological development of earth-based and satellite observational instrumentation, the emergence of sophisticated modeling and computational methods, and the availability of high-speed, high-volume communications capabilities set the stage for investigations and studies that were previously impossible.

The activities proposed by NSF are part of major international efforts to understand natural phenomena that do not recognize regional and national boundaries, yet can have profound impact on the public welfare and economic conditions of nations. Increased understanding of the earth's processes can lead to more reliable prediction of natural events such as the El Nino oceanic/atmospheric phenomenon, earthquakes and volcanic eruptions, and the consequences of human activity, such as acid rain and deforestation.

Through this research emphasis, studies of global ocean and atmospheric circulation, biogeochemical fluxes, tropospheric chemistry, solid earth properties, and ecosystems will be supported. The results will further the development of a cohesive approach to global scientific studies, and through the creation of new data sets, they will directly invigorate the constituent basic science disciplines.

Broadening Participation in Science and Engineering Research and Education

Most of the research supported by NSF is conducted at the Nation's large research-oriented institutions. Women, minorities, smaller institutions, (including undergraduate institutions and minority institutions), and some geographic areas of the country have tended to be underrepresented in the scientific establishment. NSF seeks to include a broader range of institutions and groups because we believe that scientific and engineering research progress can be accelerated if the widest possible breadth of national talent is included in the effort. Special efforts have been made both through targeted programs and programs that are integrated into all of the activities of the Foundation to systematically address underrepresentation issues.

In FY 1987, the Foundation will extend and complement previous activities to increase the numbers of minorities who choose science and engineering careers, assist selected states to increase their science and engineering capacity, and increase opportunities for undergraduate faculty and students to participate in research.

The Minority Research Centers of Excellence program, to be conducted through the Scientific, Technological and International Affairs Activity, will establish a limited number of centers that will work to increase the number of minorities in science and engineering by assisting them to develop research capabilities and interests across the spectrum of educational levels. In FY 1987, \$4 million is requested for this program which will complement the ongoing targeted programs for minority researchers and institutions, namely Minority Research Initiation and Research Improvement in Minority Institutions.

The Experimental Program to Stimulate Competitive Research will be increased by \$2 million to \$4 million. This will allow up to eight states to implement 5-year plans to improve their scientific and engineering research and training capacity. The first group of EPSCoR awards was initiated in FY 1978 and based on the success of this effort was opened to a second group of states in FY 1985. One of the states to receive an EPSCoR award in FY 1985 was Arkansas. A device developed by University of Arkansas scientists has been named by Industrial Research and Development magazine as one of the 100 most important technological advances of 1985. The development of this electron diffraction instrument was partially funded through the EPSCoR award.

In FY 1987, NSF intends to emphasize undergraduate research and education by augmenting its ongoing undergraduate activities by \$13 million over a base of nearly \$50 million. Support for research and education at the undergraduate level is provided through both the disciplinary research activities and the Science and Engineering Education Activity.

The FY 1987 undergraduate emphasis will help build an improved undergraduate environment to stimulate students to consider careers and graduate work in the sciences and engineering. A three-pronged approach is planned:

- o Undergraduate research participation will be expanded and strengthened;
- o Imaginative approaches to individual faculty development will be encouraged; and
- o Instructional equipment will be provided.

Direct involvement in research can enrich the educational experience for undergraduate students and enable them to make informed decisions on possible careers and graduate study. Funds are included in the undergraduate emphasis for engineers, scientists and mathematicians to bring together small groups of students to participate in the conduct of research. Special efforts will be made to ensure the participation of students from predominantly undergraduate institutions, where research opportunities for undergraduate students have been limited. In addition, the participation of women, minority, and disabled students will be strongly encouraged.

Excellence in undergraduate science, mathematics, and engineering education requires faculty who are current in their fields. Undergraduate faculty need opportunities to do research, to associate with other researchers in their fields, and to bring the results of research and technology into the undergraduate environment. Traditional activities such as research sabbaticals, participation in industrial research, special short courses and workshops will be supported. Other approaches, such as building enduring partnerships between a four-year college and a university research organization or industrial laboratory, will be encouraged also. Projects will be supported not only at colleges and universities, but also at national centers and laboratories, industrial R&D facilities, and specialized scientific institutions such as museums.

The College Science Instrumentation Activity will be enhanced. Through this approach undergraduate students will have the opportunity to learn to use modern instrumentation similar to that which they will encounter in industrial settings. In addition, this instrumentation will allow some institutions to enrich the range of their undergraduate offerings and, in many cases, to provide the possibility of meaningful undergraduate research.

ACTIVITY SUMMARIES

Mathematical and Physical Sciences

In FY 1987, the Mathematical and Physical Sciences (MPS) Activity requests \$449.3 million, an increase of \$39.3 million (9.6 percent) over the FY 1986 Current Plan of \$410.0 million. The FY 1987 program maintains the research base across the MPS disciplines, provides for instrumentation and operation of major facilities, and maintains the number and size of individual investigator research awards. Support for graduate students and postdoctorals is also sustained.

Within the base disciplinary programs, MPS will continue to enhance support for graduate students and postdoctorals in mathematics, an emphasis begun in FY 1984. Research on foundations of computer science will be highlighted; in chemistry increased support for shared instrumentation will be provided; and in materials research expansion of the Materials Research Groups program will be emphasized. In physics, development and improvement of instruments and facilities will be emphasized. Further planning studies for a gravitational wave detector system will be supported along with continued improvements to the Cornell Electron Storage Ring. Construction will continue on both the Indiana University Cooler Ring and the Michigan State University Superconducting Cyclotron.

All disciplinary areas of MPS will participate in the NSF-wide emphasis on computational science and engineering. Collaborative research, student training, and provision of equipment will be supported. Some of the research areas to be included are theoretical physics, computational methods for advanced computer architectures, condensed matter theory, theoretical and computational mathematics, and computational chemistry, a field in which Herbert A. Hauptman, winner of the 1985 Nobel Prize for Chemistry, has been an NSF grantee since the 1970's.

The chemistry subactivity of MPS is one of the principal constituents of NSF's efforts in biotechnology. The chemistry of life processes effort supports biotechnology-related research in biochemistry, synthetic and natural products chemistry, and a number of other areas.

MPS will participate in the NSF effort to increase the involvement of undergraduate students and faculty in research activities through summer research activities, support for research at undergraduate institutions, and other activities which improve the undergraduate environment. Collaboration of four-year colleges with major universities and research laboratories will be strongly encouraged.

Engineering

The FY 1987 Budget Request for Engineering (ENG) is \$185.5 million, an increase of \$23.0 million (14.2 percent) from the FY 1986 Current Plan of \$162.5 million.

The proposed FY 1987 program builds on the progress made since the Engineering Activity was restructured in 1985. The Activity seeks to expand the engineering science base in technology-driven fields such as mechanics, structures, and materials engineering and to build scientific bases in newer fields such as design, manufacturing, and computer engineering.

Restructuring the ENG Activity has enabled the Foundation to act as a catalyst for advances in emerging and critical engineering systems areas such as biotechnology, lightwave technology, and earthquake hazard mitigation. Research in critical systems proved extremely timely in Mexico, where prior to the recent devastating earthquake, a strong ground-motion instrument network was installed with support from an NSF grant, in cooperation with Mexican researchers. The instrument records have provided information which will be used to help explain why the destruction was greater than predicted.

More than half of the FY 1987 increase, \$12.0 million, is directed toward expansion of the cross-disciplinary Engineering Research Centers (ERC) program. This initiative was designed to strengthen engineering research and education by requiring cooperative efforts with industry and a team approach among departments within universities. Examples of the research areas of the ERC's established in FY 1985 are biotechnology process engineering, robotic systems in micro-electronics, and intelligent manufacturing systems. One measure of the program's success is reflected in total industrial commitments, estimated at \$13 million to date for the first six centers.

Engineering will participate in the Foundation-wide emphasis on computational science and engineering by increasing support for generic computational engineering as well as enhancing specific areas such as fluid dynamics and earthquake simulations.

Finally, ENG plans \$3 million for increased undergraduate participation and faculty improvement. Emphases include the University/Industry/Government Partnership program as well as increased support for undergraduate research assistants and special activities to increase participation of women, minorities, and the physically disabled.

Biological, Behavioral, and Social Sciences

The Biological, Behavioral, and Social Sciences (BBS) Activity requests \$282.4 million for FY 1987, an increase of \$22.3 million (8.6 percent) over the FY 1986 Current Plan of \$260.1 million.

The base program will provide funds for both instrumentation and personnel necessary for the effective conduct of research in all the research areas supported by BBS. The size and number of individual investigator awards will be sustained. Dramatic changes in the use and role of scientific instrumentation in BBS research fields will be met through a special emphasis on equipment support and instrument development. Upgrading biological field stations, expanding large-scale data bases of protein and nucleic acid sequences, and providing computational equipment for information science research are additional areas of emphasis within this effort.

BBS plays a dual role in the Foundation's emphasis on research related to biotechnology. BBS has general management and monitoring responsibility for the agency-wide effort, and its programs support a significant portion of such research. Their efforts focus on establishing interdisciplinary research groups, making critical instrumentation available, and developing a stronger research base in such areas as genetics and biochemistry. For example, David Radin of the University of California Irvine has developed a cloning procedure for guayule, a desert rubber plant whose product is almost identical to that from tropical rubber trees. This represents a first step to possible wide commercial use because a domestic natural rubber industry based on guayule would provide new productive capacity to arid lands and relieve the Nation from dependence on foreign sources of rubber.

There is also growing emphasis on developing the scientific information base on microbial ecology and ecosystems. These data provide essential baseline information for risk assessment analysis for policy decisions. Additional research on the assessment of risk and uncertainty associated with biotechnological advances will be continued by the Social and Economic Science subactivity, as will support for large social science data base projects such as the Panel Study on Income Dynamics.

BBS participation in the NSF-wide computational science and engineering emphasis will provide support for developing computational capabilities for biological process simulation in biochemistry, biophysics, and genetics, for image analysis in the neurosciences, and for advanced modeling and symbolic computing in the cognitive and social sciences.

Support for undergraduate students and faculty to participate in the research activities of BBS will be increased. This emphasis is particularly important for broadening the pool of personnel appropriately trained for the increasingly complex and multidisciplinary research areas of BBS.

Astronomical, Atmospheric, Earth, and Ocean Sciences

The FY 1987 Budget Request for the Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO) Activity is \$383.2 million, an increase of \$20.6 million (5.7 percent), over the FY 1986 Current Plan of \$362.6 million.

These multidisciplinary sciences are heavily dependent on capital facilities, expensive observational platforms, and advanced detection and data handling equipment. Base funding will maintain ongoing high quality projects and provide for the continued operation of facilities and equipment. The average size and number of individual investigator awards will be sustained. In order to maintain the base activities, funding for some instrumentation and facilities such as the Very Long Baseline Array (VLBA) has been stretched over a longer period than originally planned.

Additional effort will be concentrated in several important areas: astronomical instrumentation, especially for observation and detection; studies of the continental lithosphere; tropospheric chemistry; ocean circulation, including its interaction with the atmosphere and its effect on climate; and the physical, chemical, and biological processes controlling biogeochemical cycling in the ocean. Much of the proposed funding increase in the AAEO Activity in these areas reflects the increased emphasis on global geosciences as a coherent and coordinated interdisciplinary undertaking.

AAEO will also participate in the NSF-wide computational science and engineering emphasis. The computer modeling work at the National Center for Atmospheric Research is a prototype for this thrust. Many of the large-scale phenomena, such as oceanic and atmospheric circulation, climate, and the dynamics of the inner earth, cannot be recreated in a laboratory or sampled or measured by conventional means. Sophisticated numerical models, on the other hand, can provide significant insight into these phenomena and determine the critical processes involved.

The inclusion of undergraduate students and faculty in the research efforts of AAEO will be increased. In particular, the role of the national centers as sites for research participation by these groups will be emphasized.

Scientific, Technological and International Affairs

The Scientific, Technological and International Affairs (STIA) Activity has a Budget Request of \$47.0 million, which is an increase of \$7.5 million (18.9 percent) over the FY 1986 Current Plan amount of \$39.6 million.

STIA's own activities cut across all the scientific and engineering disciplines in the Foundation. In addition, STIA serves as a management focal point for many of the cross-disciplinary programs which are funded by the discipline-oriented research activities.

The FY 1987 Budget Request features a new program (\$4 million) to start Minority Research Centers of Excellence. The objectives are to increase the number of minority scientists and engineers and to provide better research and training capabilities at minority institutions. Along with existing programs for support of research by minority investigators (Minority Research Initiation) and Research Improvement in Minority Institutions, the new Centers of Excellence program strives to improve involvement of underrepresented minorities in the sciences and engineering.

The Request includes an increase in the Small Business Innovation Research (SBIR) program, which provides opportunities for small, high-technology business firms to perform research leading to more rapid commercialization of new products and processes. In international activities, STIA will provide continued support for a number of multilateral and bilateral cooperative science programs such as the Indo-U.S. Science and Technology Initiative. The Science Resources Studies subactivity plans additional funds in FY 1987 to continue the critical study of university facilities and instrumentation mandated by Congress in 1986.

Advanced Scientific Computing

The Advanced Scientific Computing Activity FY 1987 Budget Request of \$53.6 million represents a proposed funding increase of \$8.4 million, or 18.6 percent, over the FY 1986 Current Plan of \$45.2 million.

The Request seeks to continue and expand the recent NSF initiative, begun in FY 1985, to create an effective, efficient, accessible national supercomputer resource for academic basic research. The Activity continues to build in all aspects--centers enhancement, network development, software research, and training.

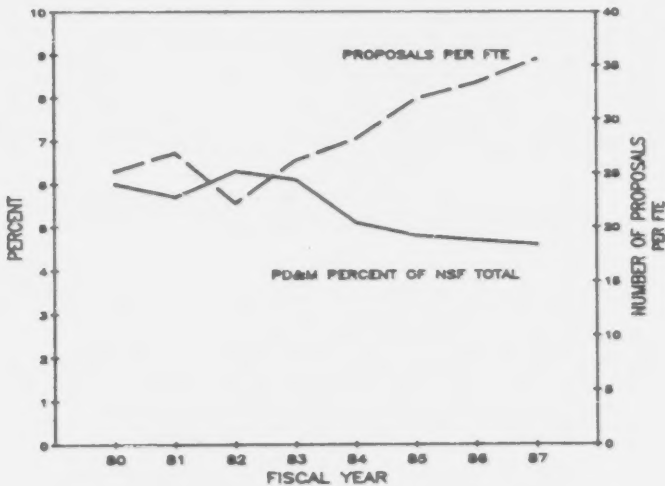
Although the program is only two years old, use of the supercomputer by a wide range of disciplinary researchers, as well as by experienced and novice users, has been greater than anticipated. The important recent achievement of Michael Rossman of Purdue University and Roland Reuckert of the University of Wisconsin in defining the structure of cold viruses, a step in the direction of establishing how medicine might intervene, was attained by use of an NSF supercomputer resource.

In FY 1987, no new national centers will be established. Rather, NSF will accelerate the development and growth of the national supercomputing centers and an experimental center. Emphasis will be placed on educating scientists and engineers in the use of this resource. Progress toward the establishment of a national science research network will continue at a steady pace. Funds for the support of the use of new technologies by researchers will be applied to the development of software, numerical methods and graphics. Arrangements for acquiring time from existing commercial or university supercomputers will continue to be phased down as the national centers become fully operational.

Program Development and Management

The Program Development and Management (PD&M) Activity increases by \$5.5 million to \$78.0 million, a 7.6 percent increase over the FY 1986 Current Plan. This Activity, which accounts for less than 5 percent of the total FY 1987 Request, provides funds for salaries and expenses to manage and administer the Foundation's program responsibilities.

Over half of the increase requested for FY 1987 is related directly to technological improvements in ADP hardware, software, and communication. Expanded capabilities in office automation and information processing are reorienting the way in which we do our work, and increasing our productivity and efficiency as highlighted below:



Improvements include the establishment of administrative support centers to move away from the traditional one-manager, one-secretary arrangement to large support groups, allowing for specialization and economies of scale; and further delegation of fiscal responsibilities to managers, giving them added flexibility to balance and optimize the resources available.

The staffing ceiling will remain at the currently authorized 1174 full-time equivalents (FTE's), which is the lowest level in a decade, and is 10 percent below the FY 1980 level of 1323. These staffing limits include the permanent workforce and the rotational personnel who spend a year or two at NSF on leave from their universities. A small part of the requested 1987 increase has been allocated to personnel compensation for higher utilization within the 1174 FTE limit.

United States Antarctic Program

The FY 1987 Request for the U.S. Antarctic Program (USAP) is \$117.0 million, an increase of \$1.8 million or 1.6 percent above the FY 1986 Current Plan of \$115.2 million. The program's objective is to maintain the U.S. presence in the Antarctic and to strengthen the scientific research activities carried out there.

The research program subactivity will fund research in glaciology, geology, meteorology, and biology--studies and analyses which are increasingly interdependent and interdisciplinary. Areas of emphasis in the coming fiscal year will include atmospheric processes, marine ecosystems, climatology and geology. Antarctic research not only illuminates regional phenomena, but also is of much wider interest, providing a unique natural laboratory.

Pursuing the continent's unique scientific opportunities entails extraordinary logistic requirements. The operations support subactivity provides for these. In 1987, increases are planned for badly-needed improvements to facilities and instrumentation. Other facility, equipment, and aircraft operation and maintenance will also be funded. Icebreaker costs, formerly reimbursed from this subactivity, have been transferred to the budget of the U.S. Coast Guard.

Science and Engineering Education

The FY 1987 Budget Request for Science and Engineering Education (SEE) is \$89.0 million or 2.2 percent (\$1.95 million) over the FY 1986 Current Plan of \$87.0 million. The FY 1986 Current Plan includes \$31.5 million carried forward from FY 1985.

The Foundation's primary management goal for the SEE Activity is stability after several years marked by extreme budget fluctuations. Therefore, all of the ongoing programs of the Activity are maintained at their FY 1986 level except for the College Science Instrumentation subactivity, which is increased by \$2.0 million. SEE will support about 560 new graduate fellowship awards (for a total of about 1500 new and continuing fellows), materials development projects in elementary and middle school mathematics and science, the preparation of pre-service and in-service elementary and secondary school mathematics and science teachers, informal science education activities at museums, and special studies and assessments.

The College Science Instrumentation subactivity increase will allow support for about 75-80 additional projects. While instructional instrumentation needs are pervasive across all science and engineering disciplines, the situation in engineering schools is particularly acute and the 1987 increase will be focused on this area. In particular, these schools lack technologically up-to-date equipment such as robots, programmable testing equipment, analog simulators, and lasers.

The programs of the Activity are closely coordinated with the Department of Education and state and local education groups. They are characterized by the strong encouragement of partnerships between governments, schools, non-profit and industrial groups.

In FY 1987 the Science and Engineering Education Activity will be closely involved in the Foundation-wide emphasis on undergraduate research and education. The College Science Instrumentation effort will continue to be coordinated carefully with research instrumentation programs and joint funding opportunities encouraged. SEE will serve as a focal point for monitoring and tracking the undergraduate activities of the Foundation.

Special Foreign Currency

In FY 1987, the Special Foreign Currency Activity requests \$0.7 million, a decrease of \$0.3 million from the FY 1986 Current Plan.

This Activity uses local excess currency to support U.S. scientific research and related goals in Pakistan. The decrease in FY 1987 reflects a systematic depletion of the available excess currency.

Through this Activity, NSF supports cooperative research, seminars and scientific visits, with research topics focusing on areas involving unique resource sites, for example the geology of the Himalayas.

EXPLANATION OF PRIOR YEAR CARRYOVER

In addition to the FY 1986 appropriations, unobligated balances totaling \$31,752,878 are available for obligation in FY 1986. The sources of these funds are:

- o No-Year Funds - Prior to FY 1974, NSF appropriations were made on a no-year basis and unobligated funds were available until expended. As a result of the deobligation in FY 1985 of obligations made in previous years, there is a balance of \$61,581 available for obligation in FY 1986.
- o The unobligated balance of the FY 1985 Research and Related Activities Appropriation is \$135,387 and results from relatively minor balances in over 300 individual operating plan accounts. The FY 1986 Current Plan reflects this balance in the Small Business Innovation Research Program and the Oceanographic Research Facilities Program.
- o Science and Engineering Education Activities - \$31,494,325 of unobligated FY 1985 appropriation remains available for obligation in FY 1986. Of this amount, \$31,450,000 was deferred in FY 1985 and \$44,325 is the unobligated balance of funds available for obligation in FY 1985. The unobligated funds will be used in FY 1986 for the planned FY 1985 activities.
- o Special Foreign Currency - A total of \$2,417 of unobligated FY 1985 funds will be utilized in the FY 1986 Program.
- o U.S. Antarctic Program - A total of \$59,168 remained unobligated at the end of FY 1985 and will be available for use during FY 1986.

**BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY
SHOWING DOLLAR AND PERCENTAGE CHANGES: FY 1987/FY 1986**

(Dollars in Millions)

Activity & Subactivity	Actual FY 1985	Current Plan FY 1986	Estimate 1987	DIFFERENCE FY 1987/1986	
				Amount	Percent
RESEARCH AND RELATED ACTIVITIES					
Mathematical and Physical Sciences					
Mathematical Sciences.....	\$ 47.7	\$ 51.7	\$ 59.8	\$ 8.1	15.7
Computer Research.....	39.1	40.2	44.5	4.3	10.7
Physics.....	115.8	118.6	126.6	8.0	6.7
Chemistry.....	87.6	89.8	101.0	11.2	12.5
Materials Research.....	107.0	109.7	117.4	7.7	7.0
Subtotal, MPS.....	\$397.2	\$410.0	\$ 449.3	\$ 39.3	9.6
Engineering					
Chemical, Biochemical & Thermal Engineering.....	29.2	29.2	30.2	1.0	3.4
Mechanics, Structures & Materials Eng.	23.3	23.7	25.3	2.6	11.0
Electrical, Communications & Systems Eng. ..	25.8	25.7	26.3	0.6	2.3
Design, Manufacturing & Computer Eng.	17.5	18.7	21.7	3.0	16.0
Emerging and Critical Systems.....	34.9	36.2	43.0	6.8	18.8
Cross-Disciplinary Research.....	19.4	29.0	38.0	9.0	31.0
Subtotal, ENG.....	150.6	162.5	185.5	23.0	14.2
Biological, Behavioral and Social Sciences					
Molecular Biology.....	60.9	62.0	67.1	5.1	8.2
Cellular Biology.....	52.4	52.1	56.6	4.5	8.6
Biotic Systems and Resources.....	58.1	61.0	66.5	5.5	9.0
Behavioral and Neural Sciences.....	44.4	45.7	48.9	3.2	7.0
Social and Economic Sciences.....	28.8	30.0	31.4	1.4	4.7
Information and Science Technology.....	8.9	9.3	11.9	2.6	27.9
Subtotal, BBS.....	253.5	260.1	282.4	22.3	8.6
Astronomical, Atmospheric, Earth and Ocean Sciences					
Astronomical Sciences.....	82.8	84.2	85.1	0.9	1.1
Atmospheric Sciences.....	95.0	96.8	100.6	3.8	3.9
Earth Sciences.....	45.9	49.0	55.0	6.0	12.2
Ocean Sciences.....	121.3	124.1	133.6	9.5	7.7
Arctic Research Program.....	8.0	8.5	8.9	0.4	4.7
Subtotal, AASO.....	353.0	362.6	383.2	20.6	5.7
Scientific, Technological and International Affairs					
Industrial Science & Technological Innov. ..	13.4	15.9	17.2	1.3	8.2
International Cooperative Scientific Activ. ..	12.4	10.8	12.6	1.8	16.7
Policy Research Analysis.....	5.2	1.9	2.0	0.1	5.3
Science Resources Studies.....	4.1	3.9	4.2	0.3	7.7
Research Initiation and Improvement.....	8.6	7.0	11.0	4.0	57.1
Subtotal, STIA.....	43.7	39.5	47.0	7.5	18.9
Advanced Scientific Computing.....	41.4	45.2	53.6	8.4	18.6
Program Development and Management.....	72.0	72.5	78.0	5.5	7.6
TOTAL, R&A.....	1,311.4	1,352.4	1,479.0	126.6	9.4
U.S. ANTARCTIC PROGRAM					
U.S. Antarctic Research Program.....	11.1	11.5	12.0	0.5	4.3
Operations Support Program.....	99.7	103.7	105.0	1.3	1.3
TOTAL, USAP.....	110.8	115.2	117.0	1.8	1.6
SCIENCE AND ENGINEERING EDUCATION					
Research Career Development.....	27.3	27.3	27.3	-0-	-0-
Materials Development, Research and Informal Science Education.....	22.7	25.0	25.0	-0-	-0-
Teacher Preparation and Enhancement.....	25.2	27.0	27.0	-0-	-0-
Studies and Program Assessment.....	1.8	2.2	2.2	-0-	-0-
College Science Instrumentation.....	5.0	5.5	7.5	2.0	36.4
TOTAL, SEE.....	82.0	87.0	89.0	2.0	2.3
SPECIAL FOREIGN CURRENCY.....	2.8	1.0	0.7	-0.3	-30.0
TOTAL, NSF.....	\$1,507.0	\$1,555.6	\$1,685.7	\$130.1	8.4

**SUMMARY BUDGET INFORMATION BY SUBACTIVITY,
ACTIVITY AND APPROPRIATION: FY 1985 - FY 1987**

	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
RESEARCH AND RELATED ACTIVITIES					
Mathematical and Physical Sciences..	\$397,188,087	\$428,970,000	\$409,970,000	\$449,250,000	\$39,280,000
Engineering.....	150,628,125	170,070,000	162,475,000	185,470,000	22,995,000
Biological, Behavioral, and Social Sciences.....	253,510,645	272,050,000	260,070,000	282,410,000	22,340,000
Astronomical, Atmospheric, Earth, and Ocean Sciences.....	353,026,753	372,170,000	362,596,968	383,210,000	20,613,032
Scientific, Technological, and International Affairs.....	43,743,769	38,360,000	39,560,000	47,030,000	7,470,000
Advanced Scientific Computing.....	41,395,653	46,230,000	45,230,000	53,630,000	8,400,000
Program Development and Management..	71,951,270	69,900,000	72,500,000	78,000,000	5,500,000
Subtotal, RRA.....	1,311,444,100	1,397,750,000	1,352,401,968	1,479,000,000	126,598,032
Unobligated Balances and Other Adjustments.....	-10,432,300	-0-	-196,968	-0-	196,968
Research and Related Activities Appropriation.....	1,301,012,000	1,397,750,000	1,352,205,000	1,479,000,000	126,795,000
U.S. ANTARCTIC PROGRAM ACTIVITIES					
U.S. Antarctic Research Program.....	11,155,519	11,500,000	11,500,000	12,000,000	500,000
Operations Support.....	99,685,066	108,600,000	103,659,168	105,000,000	1,340,832
Subtotal, U.S. Antarctic Program Activities.....	110,840,585	120,100,000	115,159,168	117,000,000	1,840,832
Unobligated Balances and Other Adjustments.....	-10,585	-0-	-59,168	-0-	59,168
U.S. Antarctic Activities Appropriation.....	110,830,000	120,100,000	115,100,000	117,000,000	1,900,000
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION					
Research Career Development.....	27,291,922	27,300,000	27,344,325	27,300,000	-44,325
Materials Development, Research and Informal Science Education....	22,725,418	23,700,000	25,000,000	25,000,000	-0-
Teacher Preparation and Enhancement..	25,188,387	24,000,000	27,000,000	27,000,000	-0-
Studies and Program Assessment.....	1,747,713	2,000,000	2,200,000	2,200,000	-0-
College Science Instrumentation.....	4,996,379	5,000,000	5,500,000	7,500,000	2,000,000
Subtotal, Science and Engineering Activities.....	81,955,819	82,000,000	87,044,325	89,000,000	1,955,675
Unobligated Balances and Other Adjustments.....	5,044,181	-31,450,278	-31,494,325	-0-	31,494,325
Science and Engineering Education Activities Appropriation.....	87,000,000	50,549,722	55,550,000	89,000,000	33,450,000
SPECIAL FOREIGN CURRENCY APPROPRIATION					
Special Foreign Currency.....	2,829,505	1,000,000	1,002,417	700,000	-302,417
Unobligated Balances and Other Adjustments.....	-29,505	-0-	-2,417	-0-	2,417
Special Foreign Currency Appropriation.....	2,800,000	1,000,000	1,000,000	700,000	-300,000
TOTAL NSF APPROPRIATIONS.....	\$1,501,642,000	\$1,569,399,722	\$1,523,855,000	\$1,685,700,000	\$161,845,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
A. MATHEMATICAL AND PHYSICAL SCIENCES					
I. MATHEMATICAL SCIENCES					
Classical Analysis.....	\$4,553,824	\$5,155,000	\$5,015,000	\$5,767,000	\$752,000
Modern Analysis.....	4,659,121	5,490,000	5,090,000	5,861,000	771,000
Geometric Analysis.....	4,518,028	5,220,000	4,951,000	5,692,000	741,000
Topology and Foundations.....	5,701,868	6,635,000	6,161,000	7,085,000	924,000
Algebra and Number Theory.....	7,909,851	9,110,000	8,581,000	9,868,000	1,287,000
Applied Mathematics.....	6,417,832	7,640,000	7,030,000	8,907,000	1,877,000
Statistics and Probability.....	5,601,757	6,690,000	6,170,000	7,440,000	1,270,000
Special Projects.....	8,367,523	8,550,000	8,742,000	9,180,000	438,000
Total, Mathematical Sciences.....	47,729,804	54,690,000	51,740,000	59,800,000	8,060,000
II. COMPUTER RESEARCH					
Theoretical Computer Science.....	4,857,972	4,750,000	\$5,150,000	\$5,580,000	430,000
Software Systems Science.....	4,239,998	4,400,000	4,800,000	5,470,000	670,000
Software Engineering.....	3,574,014	3,850,000	3,850,000	4,930,000	1,080,000
Intelligent Systems.....	5,221,667	5,400,000	5,350,000	5,670,000	320,000
Computer Systems Design.....	3,601,724	4,180,000	3,500,000	3,470,000	-30,000
Coordinated Experimental Research.....	15,118,993	16,300,000	15,100,000	14,400,000	-700,000
Special Projects.....	1,018,290	1,060,000	920,000	3,420,000	2,500,000
Computer Research Equipment.....	1,491,789	1,790,000	1,500,000	1,500,000	0
Total, Computer Research.....	39,124,447	41,730,000	40,170,000	46,440,000	4,270,000
III. PHYSICS					
Elementary Particle Physics.....	39,777,900	44,770,000	42,130,000	45,690,000	3,560,000
Intermediate Energy Nuclear Physics.....	18,344,705	18,800,000	18,800,000	18,800,000	0
Nuclear Physics.....	22,992,847	23,400,000	21,600,000	21,220,000	-380,000
Atomic, Molecular, and Plasma Physics.....	13,599,076	13,700,000	13,700,000	13,930,000	230,000
Theoretical Physics.....	13,866,989	14,400,000	14,400,000	15,970,000	1,570,000
Gravitational Physics.....	7,213,483	8,300,000	8,000,000	11,030,000	3,030,000
Total, Physics.....	115,795,000	123,370,000	118,630,000	126,640,000	8,010,000
IV. CHEMISTRY					
Structural Chemistry and Thermodynamics.....	15,020,125	15,910,000	15,537,000	17,140,000	1,603,000
Chemical Physics.....	14,406,735	15,190,000	14,902,000	16,650,000	1,748,000
Chemical Dynamics.....	15,533,547	15,990,000	15,966,000	17,640,000	1,674,000
Chemical Analysis.....	11,147,288	12,610,000	11,345,000	12,510,000	1,165,000
Synthetic Inorganic and Organometallic Chemistry.....	9,274,483	10,360,000	9,470,000	10,650,000	1,180,000
Synthetic Organic and Natural Products Chemistry.....	10,585,362	11,930,000	10,950,000	12,330,000	1,380,000
Chemical Instrumentation.....	11,595,766	11,510,000	11,610,000	14,100,000	2,490,000
Total, Chemistry.....	87,563,306	93,500,000	89,780,000	101,020,000	11,240,000
V. MATERIALS RESEARCH					
Solid State Physics.....	11,448,350	12,400,000	11,885,000	12,370,000	485,000
Solid State Chemistry.....	8,155,950	9,100,000	8,662,000	9,100,000	438,000
Low Temperature Physics.....	7,933,250	8,400,000	8,178,000	8,520,000	342,000
Condensed Matter Theory.....	8,247,950	8,900,000	8,502,000	9,470,000	968,000
Metallurgy.....	9,483,705	10,200,000	9,810,000	10,180,000	370,000
Ceramics and Electronic Materials.....	6,479,498	6,780,000	6,597,000	6,860,000	263,000
Polymers.....	7,561,981	7,600,000	7,121,000	7,460,000	339,000
Instrumentation for Materials Research.....	6,500,900	6,600,000	6,245,000	6,240,000	-5,000
Materials Research Laboratories.....	27,073,410	30,000,000	27,200,000	27,700,000	500,000
National Facilities.....	11,590,161	12,000,000	10,650,000	10,650,000	0
Materials Research Groups.....	2,500,375	3,700,000	4,800,000	8,800,000	4,000,000
Total, Materials Research.....	106,975,530	115,680,000	109,650,000	117,350,000	7,700,000
TOTAL, NPS.....	\$397,188,087	\$428,970,000	\$409,970,000	\$449,250,000	\$39,280,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE
B. ENGINEERING					
I. ENGINEERING SCIENCE IN CHEMICAL, BIOCHEMICAL, AND THERMAL ENGINEERING					
Kinetics and Catalysis Engineering.....	\$ 2,974,041	\$ 3,450,000	\$ 3,100,000	\$ 3,340,000	\$ 240,000
Biochemical and Biomass Engineering.....	3,072,429	2,880,000	3,030,000	2,560,000	-470,000
Process and Reaction Engineering.....	3,529,415	3,230,000	3,450,000	3,710,000	260,000
Multiphase and Interfacial Phenomena.....	3,318,000	3,600,000	3,400,000	3,560,000	160,000
Separation and Purification Processes.....	2,930,613	3,500,000	3,100,000	3,240,000	140,000
Thermodynamics and Transport Phenomena....	4,556,104	4,440,000	4,600,000	4,750,000	150,000
Thermal Systems and Engineering.....	8,797,024	8,260,000	8,500,000	9,050,000	550,000
Total, CITE.....	29,177,628	29,360,000	29,180,000	30,210,000	1,030,000
II. ENGINEERING SCIENCE IN MECHANICS, STRUCTURES, AND MATERIALS ENGINEERING					
Solid and Geomechanics.....	4,012,742	5,460,000	6,100,000	6,470,000	370,000
Structures and Building Systems.....	4,259,563	4,400,000	3,900,000	3,610,000	-290,000
Fluid Dynamics and Hydraulics.....	5,306,073	5,400,000	5,600,000	6,130,000	530,000
Tribology.....	1,890,700	2,040,000	2,000,000	2,150,000	150,000
Dynamic Systems and Control.....	2,782,527	2,850,000	2,800,000	2,910,000	110,000
Materials Engineering and Processing.....	3,058,128	3,300,000	3,300,000	5,000,000	1,700,000
Total, ASME.....	22,308,733	23,450,000	23,700,000	26,270,000	2,570,000
III. ENGINEERING SCIENCE IN ELECTRICAL, COMMUNICATIONS & SYSTEMS ENGINEERING					
Solid State and Microstructures.....	7,701,563	7,700,000	7,200,000	7,250,000	50,000
Communications Systems and Signal Processing.....	5,143,752	5,200,000	5,300,000	5,500,000	200,000
Systems Theory and Operations Research.....	5,057,593	5,200,000	5,200,000	5,400,000	200,000
Quantum Electronics, Waves and Beams.....	4,932,924	4,600,000	4,900,000	4,980,000	80,000
Instrumentation, Sensing and Measurement..	2,969,454	3,980,000	3,100,000	3,140,000	40,000
Total, ECSE.....	25,805,286	26,680,000	25,700,000	26,270,000	570,000
IV. SCIENCE BASE DEVELOPMENT IN DESIGN, MANUFACTURING, & COMPUTER ENGINEERING					
Computer Engineering.....	5,310,227	5,460,000	5,700,000	7,500,000	1,800,000
Design Theory and Methodology.....	1,623,390	3,000,000	2,800,000	3,200,000	400,000
Computer Integrated Engineering.....	1,610,203	3,000,000	2,000,000	2,250,000	250,000
Manufacturing Systems.....	5,064,732	4,970,000	5,100,000	5,270,000	170,000
Automation and Systems Integration.....	3,855,751	3,960,000	3,100,000	3,450,000	350,000
Total, DMCE.....	17,464,303	20,390,000	18,700,000	21,670,000	2,970,000
V. FUNDAMENTAL RESEARCH FOR EMERGING AND CRITICAL ENGINEERING SYSTEMS					
Biotechnology.....	1,529,217	4,300,000	3,000,000	5,000,000	2,000,000
Bioengineering and Research for the Handicapped.....	4,645,317	4,680,000	4,700,000	5,060,000	360,000
Computational Engineering.....	0	0	0	3,000,000	3,000,000
Lightwave Technology.....	2,035,881	3,000,000	3,000,000	3,230,000	230,000
Earthquake Hazard Mitigation.....	17,083,982	18,400,000	13,700,000	16,500,000	800,000
Environmental Engineering.....	4,374,814	5,480,000	4,365,000	4,420,000	55,000
Systems Engineering for Large Structures..	2,896,104	2,580,000	2,900,000	3,120,000	220,000
Natural and Man-Made Hazard Mitigation....	2,395,592	2,060,000	2,530,000	2,720,000	190,000
Total, ECES.....	34,960,807	38,500,000	36,195,000	43,050,000	6,855,000
VI. CROSS-DISCIPLINARY RESEARCH					
Engineering Research Centers.....	10,007,782	25,000,000	23,000,000	35,000,000	12,000,000
Industry/University Research Projects.....	6,917,942	3,490,000	3,000,000	0	-3,000,000
Industry/University Research Centers.....	2,984,544	3,000,000	3,000,000	3,000,000	0
Total, CDR.....	19,910,268	31,490,000	29,000,000	38,000,000	8,000,000
TOTAL, ENGINEERING.....	\$150,628,125	\$170,070,000	\$162,475,000	\$183,470,000	\$22,995,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
C. BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES					
I. MOLECULAR BIOSCIENCES					
Biological Instrumentation.....	58,017,766	58,410,000	58,300,000	\$10,000,000	\$1,700,000
Biochemistry.....	13,960,935	15,749,000	15,130,000	16,090,000	960,000
Biophysics.....	13,721,348	15,310,000	14,700,000	15,800,000	1,100,000
Prokaryotic Genetics.....	8,231,474	8,960,000	8,800,000	9,660,000	860,000
Metabolic Biology.....	14,522,109	15,701,000	15,000,000	15,550,000	550,000
Alternative Biological Resources.....	2,473,180	0	0	0	0
Total, Molecular Biosciences.....	60,826,812	64,130,000	61,830,000	67,100,000	5,170,000
II. CELLULAR BIOSCIENCES					
Cell Biology.....	11,645,378	11,670,000	11,700,000	12,180,000	980,000
Cellular Physiology.....	8,213,729	8,650,000	8,100,000	9,020,000	920,000
Developmental Biology.....	13,390,289	14,640,000	14,010,000	14,970,000	960,000
Eukaryotic Genetics.....	8,658,345	9,220,000	9,040,000	10,040,000	1,000,000
Regulatory Biology.....	10,477,193	10,200,000	9,780,000	10,380,000	600,000
Total, Cellular Biosciences.....	52,384,934	54,380,000	52,130,000	56,590,000	4,460,000
III. BIOTIC SYSTEMS AND RESOURCES					
Ecology.....	8,885,543	10,050,900	9,731,900	10,930,000	1,198,100
Ecosystem Studies.....	17,393,221	19,300,000	18,487,440	20,790,000	2,102,560
Systematic Biology.....	12,231,493	13,023,300	12,611,000	13,450,000	839,000
Population Biology and Physiological Ecology.....	10,212,310	10,667,500	10,329,000	11,180,000	851,000
Biological Research Resources.....	9,398,251	9,978,300	9,660,660	10,160,000	499,340
Total, Biotic Systems and Resources.....	58,120,818	63,020,000	61,020,000	66,510,000	5,490,000
IV. BEHAVIORAL AND NEURAL SCIENCES					
Anthropology.....	7,409,446	7,300,000	7,300,000	7,780,000	480,000
Linguistics.....	3,271,914	3,220,000	3,150,000	3,300,000	150,000
Memory and Cognitive Processes.....	4,771,970	4,600,000	4,000,000	4,200,000	200,000
Social and Developmental Psychology.....	3,130,648	3,230,000	3,150,000	3,300,000	150,000
Developmental Neuroscience.....	4,971,736	5,650,000	5,550,000	6,150,000	600,000
Integrative Neural Systems.....	4,355,520	5,200,000	5,100,000	5,500,000	400,000
Molecular and Cellular Neurobiology.....	4,983,898	5,550,000	5,550,000	6,150,000	600,000
Psychobiology.....	4,742,135	4,730,000	4,730,000	5,030,000	300,000
Sensory Physiology and Perception.....	6,741,161	7,650,000	7,160,000	7,460,000	300,000
Total, Behavioral and Neural Sciences.....	44,378,428	47,130,000	45,680,000	48,870,000	3,180,000
V. SOCIAL AND ECONOMIC SCIENCE					
Economics.....	10,065,136	14,340,000	12,000,000	12,600,000	600,000
Geography.....	1,292,700	1,600,000	1,600,000	1,680,000	80,000
Sociology.....	4,604,916	4,200,000	3,700,000	3,800,000	100,000
Measurement Methods and Data Improvement.....	3,387,326	3,800,000	3,700,000	3,700,000	0
History and Philosophy of Science.....	1,704,490	2,200,000	1,620,000	1,750,000	130,000
Political Science.....	3,314,788	4,100,000	3,700,000	3,800,000	100,000
Law and Social Sciences.....	1,902,361	2,200,000	1,620,000	1,750,000	130,000
Regulation and Policy Analysis.....	1,089,998	0	0	0	0
Decision and Management Science.....	1,389,931	1,450,000	2,100,000	2,350,000	250,000
Total, Social and Economic Sciences.....	28,751,646	33,890,000	30,040,000	31,430,000	1,390,000
VI. INFORMATION SCIENCE AND TECHNOLOGY					
Information Science.....	5,392,846	5,500,000	5,370,000	6,910,000	1,540,000
Information Technology.....	1,783,729	2,000,000	1,945,000	2,500,000	555,000
Information Impact.....	1,761,432	2,000,000	1,945,000	2,500,000	555,000
Total, Information Science and Tech....	8,948,007	9,500,000	9,260,000	11,910,000	2,650,000
TOTAL, NBS.....	253,510,645	272,050,000	260,070,000	282,610,000	22,540,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
D. ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES					
I. ASTRONOMICAL SCIENCES					
Astronomy Project Support					\$0
Solar System Astronomy.....	\$1,249,957	\$1,300,000	\$1,250,000	\$1,250,000	540,000
Stars and Stellar Evolution.....	5,955,856	6,600,000	6,440,000	6,980,000	670,000
Galactic Astronomy.....	4,810,183	5,000,000	4,990,000	5,660,000	530,000
Extragalactic Astronomy.....	7,192,664	8,200,000	8,040,000	8,570,000	
Astronomical Instrumentation and Development.....	7,925,691	7,360,000	6,790,000	5,140,000	-1,650,000
Electromagnetic Spectrum Management.....	100,000	100,000	100,000	100,000	0
Subtotal, Astronomy Project support.	27,234,351	28,560,000	27,610,000	27,700,000	90,000
National Astronomy and Ionosphere Center					
Scientific Research Support.....	6,385,000	6,665,000	6,475,000	6,425,000	-50,000
Less NASA Support.....	-335,000	-315,000	-325,000	-325,000	0
Subtotal, NAIC.....	6,050,000	6,350,000	6,150,000	6,100,000	-50,000
National Optical Astronomy Observatories					
Scientific Research Support.....	22,883,767	24,068,000	23,983,000	24,400,000	417,000
Management Fee.....	378,000	417,000	417,000	430,000	13,000
Less DOD Support.....	-435,000	-435,000	-600,000	-630,000	-50,000
Subtotal, NGAO.....	22,826,767	24,050,000	23,800,000	24,200,000	400,000
National Radio Astronomy Observatory					
Scientific Research Support.....	17,303,000	17,830,000	17,280,000	17,260,000	-20,000
VLA Construction.....	9,000,000	11,500,000	9,000,000	9,400,000	400,000
Management Fee.....	350,000	380,000	380,000	400,000	20,000
Subtotal, NRAO.....	26,653,000	29,710,000	26,660,000	27,060,000	400,000
Total, Astronomy.....	82,764,118	88,670,000	84,220,000	85,060,000	840,000
II. ATMOSPHERIC SCIENCES					
Atmospheric Sciences Project Support					
Aeronomy.....	6,469,039	6,701,000	6,521,000	6,583,000	62,000
Atmospheric Chemistry.....	7,101,438	7,249,000	7,289,000	9,201,000	1,912,000
Climate Dynamics.....	7,578,154	7,848,000	7,890,000	8,602,000	712,000
Experimental Meteorology.....	5,110,000	5,514,000	5,990,000	5,553,000	-437,000
Global Atmospheric Research Program.....	4,887,800	3,900,000	4,595,000	3,835,000	-760,000
Meteorology.....	8,948,600	9,720,000	9,683,000	10,031,000	348,000
Solar Terrestrial Research.....	7,524,840	7,713,000	7,447,000	7,521,000	74,000
Subtotal, Atmospheric Sciences Proj..	47,619,871	48,643,000	49,413,000	51,326,000	1,911,000
National Center for Atmospheric Research					
Atmospheric Analysis and Prediction.....	3,578,000	3,727,000	3,487,000	3,766,000	279,000
Atmospheric Chemistry and Aeronomy.....	2,745,100	2,821,000	2,694,000	3,477,000	783,000
Convective Storms.....	2,426,300	2,488,000	2,302,000	2,351,000	49,000
Advanced Study Programs.....	1,405,600	1,445,000	1,348,000	1,543,000	195,000
High Altitude Observatory.....	3,529,600	3,613,000	3,388,000	3,390,000	2,000
Atmospheric Technology.....	7,268,900	7,454,000	7,157,000	7,346,000	189,000
Scientific Computing.....	11,485,800	11,821,000	12,965,000	13,819,000	854,000
Administration and Support Services.....	4,761,356	5,273,000	4,957,000	4,740,000	-217,000
Physical Plant Operation and Maintenance.....	5,268,400	5,243,000	3,749,000	3,671,000	-78,000
Contractor Fee.....	1,034,000	1,021,000	1,088,000	1,088,000	0
Subtotal, NCAR.....	43,503,056	44,906,000	43,135,000	43,191,000	2,056,000
Upper Atmospheric Facilities.....	3,940,730	4,089,000	4,230,000	4,133,000	-97,000
Subtotal, Atmospheric Sciences.....	85,063,657	97,640,000	96,790,000	100,630,000	3,870,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
D. ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES, continued					
III. EARTH SCIENCES					
Stratigraphy and Paleontology.....	3,849,000	3,800,000	3,800,000	4,000,000	200,000
Surficial Processes.....	2,925,434	2,900,000	2,900,000	3,300,000	400,000
Crustal Structure and Tectonics.....	3,900,000	3,900,000	3,900,000	4,100,000	200,000
Sismology.....	4,715,424	4,600,000	4,600,000	4,800,000	200,000
Experimental and Theoretical					
Geophysics.....	4,954,899	4,900,000	4,900,000	5,200,000	300,000
Petrogenesis and Mineral Resources..	4,049,499	4,000,000	4,000,000	4,300,000	300,000
Volcanology and Mantle Geochemistry.	3,700,000	3,700,000	3,700,000	3,900,000	200,000
Experimental and Theoretical					
Geochemistry.....	6,011,451	6,000,000	6,000,000	6,100,000	100,000
Instrumentation and Facilities.....	4,693,327	6,300,000	5,000,000	5,000,000	0
Continental Lithosphere.....	7,163,143	11,400,000	10,140,000	14,250,000	4,110,000
Subtotal, Earth Sciences.....	45,852,177	51,500,000	48,940,000	54,950,000	6,010,000
IV. OCEAN SCIENCES					
Ocean Sciences Research Support					
Physical Oceanography.....	16,794,823	17,250,000	18,061,000	22,523,000	4,462,000
Chemical Oceanography.....	12,420,000	12,940,000	12,558,000	13,354,000	796,000
Marine Geology and Geophysics.....	15,232,282	15,700,000	15,360,000	16,144,000	784,000
Biological Oceanography.....	13,883,827	14,050,000	13,977,000	14,417,000	440,000
Subtotal, Ocean Sciences Research....	58,330,932	59,940,000	59,956,000	66,438,000	6,482,000
Subtotal, Oceanographic Centers and Facilities.....	35,212,619	36,790,000	35,330,968	37,172,000	1,841,032
Ocean Drilling Program					
Ocean Drilling Program.....	35,339,131	41,350,000	41,350,000	45,050,000	3,700,000
Less Foreign Funding.....	-7,607,190	-12,500,000	-12,500,000	-15,000,000	-2,500,000
Subtotal, Ocean Drilling Program.....	27,731,941	28,850,000	28,850,000	30,050,000	1,200,000
Total, Ocean Sciences.....	121,275,492	125,580,000	124,136,968	133,660,000	9,523,032
V. ARCTIC RESEARCH PROGRAM					
Arctic Research Projects.....	7,711,309	8,480,000	8,220,000	8,390,000	170,000
Arctic Research Commission.....	250,000	300,000	300,000	500,000	200,000
Total, Arctic Research Program.....	7,961,309	8,780,000	8,520,000	8,890,000	370,000
TOTAL, AARO.....	353,026,753	372,170,000	362,596,968	383,210,000	20,613,032

LEVELS OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
B. SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS					
I. INDUSTRIAL SCIENCE AND TECHNOLOGICAL INNOVATION					
Small Business Innovation Research.....	\$ 12,399,997	\$ 13,300,000	\$ 15,650,000	\$ 17,150,000	\$ 1,500,000
Productivity Improvement Research.....	1,035,754	0	200,000	0	-200,000
Total, ISTI.....	13,435,744	13,300,000	15,850,000	17,150,000	1,300,000
II. INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES					
International Cooperative Science.....	11,116,855	11,390,000	10,140,000	11,960,000	1,820,000
International Scientific Organizations and Resources.....	1,305,386	700,000	700,000	700,000	0
Total, INT.....	12,422,241	12,090,000	10,840,000	12,660,000	1,820,000
III. POLICY RESEARCH AND ANALYSIS					
Total, III.....	5,146,170	1,990,000	1,940,000	1,990,000	50,000
IV. SCIENCE RESOURCES STUDIES					
Scientific and Technical Personnel.....	2,265,210	2,090,000	2,090,000	1,840,000	-250,000
Funding of Science and Technology.....	982,791	1,300,000	1,250,000	1,700,000	450,000
Modeling and Special Science and Technology Indicators.....	891,679	600,000	600,000	700,000	100,000
Total, SR.....	4,139,680	3,990,000	3,940,000	4,240,000	300,000
V. RESEARCH INITIATION AND IMPROVEMENT					
Visiting Professorships for Women.....	2,142,524	2,000,000	2,000,000	2,000,000	0
Research Improvement in Minority Institutions.....	4,940,272	4,990,000	4,990,000	4,990,000	0
Intergovernmental Science and Technology.....	524,136	0	0	0	0
Ethics and Values in Science and Technology.....	985,000	0	0	0	0
Minority Research Centers of Excellence.....	0	0	0	4,000,000	4,000,000
Total, RI.....	8,589,932	6,990,000	6,990,000	10,990,000	4,000,000
TOTAL, STIA.....	843,743,769	838,360,000	838,360,000	847,030,000	87,470,000
F. ADVANCED SCIENTIFIC COMPUTING.....					
	841,395,653	846,230,000	845,230,000	853,430,000	88,400,000
G. PROGRAM DEVELOPMENT AND MANAGEMENT					
Program Development and Management.....	71,951,270	69,900,000	72,500,000	78,000,000	5,500,000
Full-time Equivalent, Permanent.....	1,033	1,033	1,033	1,033	-0-
Full-time Equivalent, Other.....	140	141	141	141	-0-
Subtotal.....	1,173	1,174	1,174	1,174	-0-
TOTAL, RESEARCH AND RELATED ACTIVITIES..	1,311,444,300	1,397,750,000	1,352,401,968	1,479,000,000	126,598,032
Unobligated Balances and Other Adjustments.....	-10,432,300	-0-	-196,968	-0-	196,968
Research and Related Activities Appropriation.....	\$1,301,012,000	\$1,397,750,000	\$1,352,205,000	\$1,479,000,000	\$126,795,000

LEVEL OF FUNDING BY PROGRAM - Continued

SUBACTIVITY/PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
N. U. S. ANTARCTIC PROGRAM					
I. U. S. ANTARCTIC RESEARCH PROGRAM	11,155,519	11,500,000	11,500,000	12,000,000	500,000
II. OPERATIONS SUPPORT PROGRAM					
Direct Science Support.....	14,000,000	15,300,000	15,300,000	\$16,100,000	800,000
Base Level Support.....	67,800,000	70,000,000	70,059,168	59,700,000	-10,359,168
Major Construction and Procurement.....	18,085,066	23,300,000	18,300,000	29,200,000	10,900,000
Total, OPS.....	99,685,066	108,600,000	103,659,168	105,000,000	1,340,832
Unobligated Balance and Other Adjustments.....	-10,585	-0-	-59,168	-0-	59,168
TOTAL, U. S. ANTARCTIC PROGRAM TOTAL ...	\$110,830,000	\$120,100,000	\$115,100,000	\$117,000,000	\$1,900,000
I. SCIENCE AND ENGINEERING EDUCATION					
I. RESEARCH CAREER DEVELOPMENT.....	27,297,922	27,300,000	27,344,325	27,300,000	-44,325
II. MATERIALS DEVELOPMENT, RESEARCH, AND INFORMAL SCIENCE EDUCATION.....	22,725,418	23,700,000	25,000,000	25,000,000	0
III. TEACHER PREPARATION AND ENHANCEMENT.....	25,188,387	24,000,000	27,000,000	27,000,000	0
IV. STUDIES AND PROGRAM ASSESSMENT.....	1,747,713	2,000,000	2,200,000	2,200,000	0
V. COLLEGE SCIENCE INSTRUMENTATION.....	4,996,379	5,000,000	5,500,000	7,500,000	2,000,000
TOTAL, SEE.....	\$81,955,819	\$82,000,000	\$87,044,325	\$89,000,000	\$1,955,675
Unobligated Balances and Other Adjustments.....	5,044,181	-31,450,278	-31,494,325	-0-	31,494,325
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION.....	\$7,000,000	\$0,549,722	\$5,550,000	\$9,000,000	\$3,450,000
J. SPECIAL FOREIGN CURRENCY PROGRAM					
J. SPECIAL FOREIGN CURRENCY PROGRAM.....	\$2,829,505	\$1,000,000	\$1,002,417	\$700,000	-\$302,417
Unobligated Balances and Other Adjustments.....	-29,505	-0-	-2,417	-0-	2,417
TOTAL, SPECIAL FOREIGN CURRENCY PROGRAM.....	2,800,000	1,000,000	1,000,000	700,000	-300,000
TOTAL, NSF APPROPRIATION.....	\$1,501,642,000	\$1,569,399,722	\$1,523,855,000	\$1,685,700,000	\$161,845,000

ANALYSIS OF CHANGES IN OBLIGATION LEVELS: FY 1985 - FY 1987RESEARCH AND RELATED ACTIVITIES APPROPRIATION

	Obligations
FY 1985 Obligated Level	\$1,311,444,300
FY 1986:	
Increases:	
Mathematical and Physical Sciences.....	12,781,913
Engineering.....	11,846,875
Biological, Behavioral, and Social Sciences.....	6,559,355
Astronomical, Atmospheric, Earth, & Ocean Sciences	9,570,215
Advanced Scientific Computing.....	3,834,347
Program Development and Management.....	548,732
Subtotal, Increases.....	45,141,437
Decreases:	
Scientific, Technological, & International Affairs	(4,183,769)
FY 1986 Obligated Level	1,352,401,968
FY 1987:	
Increases:	
Mathematical and Physical Sciences.....	39,280,000
Engineering.....	22,995,000
Biological, Behavioral, and Social Sciences.....	22,340,000
Astronomical, Atmospheric, Earth, & Ocean Sciences	20,613,032
Scientific, Technological, & International Affairs	7,470,000
Advanced Scientific Computing.....	8,400,000
Program Development and Management.....	5,500,000
Subtotal.....	126,598,032
FY 1987 Obligated Level	\$1,479,000,000

U.S. ANTARCTIC ACTIVITIES APPROPRIATION

	Obligations
FY 1985 Obligated Level	\$110,840,585
FY 1986:	
Increases:	
U.S. Antarctic Research Program.....	344,481
Operations Support.....	3,974,102
Subtotal.....	4,318,583
FY 1986 Obligated Level	115,159,168
FY 1987:	
Increases:	
U.S. Antarctic Research Program.....	500,000
Operations Support.....	1,340,832
Subtotal.....	1,840,832
FY 1987 Obligated Level	\$117,000,000

ANALYSIS OF CHANGES IN OBLIGATION LEVELS: FY 1985 - FY 1987, continuedSCIENCE AND ENGINEERING EDUCATIONACTIVITIES APPROPRIATION

	Obligations
<u>FY 1985 Obligated Level</u>	\$81,955,819
<u>FY 1986:</u>	
Increases:	
Research Career Development.....	46,403
Materials Development, Research, and Informal	
Science Education.....	2,274,582
Teacher Preparation and Enhancement.....	1,811,613
Studies and Program Assessment.....	452,287
College Science Instrumentation.....	503,621
Subtotal.....	5,088,506
<u>FY 1986 Obligated Level</u>	87,044,325
<u>FY 1987:</u>	
Increases:	
College Science Instrumentation.....	2,000,000
Decreases:	
Research Career Development.....	(44,325)
<u>FY 1987 Obligated Level</u>	\$89,000,000

SPECIAL FOREIGN CURRENCY APPROPRIATION

	Obligations
<u>FY 1985 Obligated Level</u>	\$2,829,505
<u>FY 1986:</u>	
Decrease:	
Special Foreign Currency Program.....	(1,827,088)
<u>FY 1986 Obligated Level</u>	1,002,417
<u>FY 1987:</u>	
Decrease:	
Special Foreign Currency Program.....	(302,417)
<u>FY 1987 Obligated Level</u>	\$700,000

PERCENTAGE DISTRIBUTION OF TOTAL OBLIGATIONS: FY 1985 - FY 1987

	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987
Research and Related Activities				
Mathematical and Physical Sciences.....	26.4%	26.8%	26.4%	26.7
Engineering.....	10.0	10.6	10.4	11.0
Biological, Behavioral, and Social Sciences.....	16.8	17.0	16.7	16.8
Astronomical, Atmospheric, Earth, and Ocean Sciences	23.4	23.2	23.3	22.7
Scientific, Technological, And International Affairs	2.9	2.4	2.5	2.8
Advanced Scientific Computing.....	2.7	2.9	2.9	3.2
Program Development and Management.....	4.8	4.6	4.7	4.6
Subtotal, Research and Related Activities.....	87.0%	87.3%	86.9%	87.8
U.S. Antarctic Program				
U.S. Antarctic Research Program.....	0.7	0.7	0.7	0.7
Operations Support Program.....	6.7	6.8	6.7	6.2
Subtotal, U.S. Antarctic Program.....	7.4%	7.5%	7.4%	6.9%
Science and Engineering Education				
Research Career Development.....	1.8	1.7	1.8	1.6
Materials Development, Research, and Informal				
Science Education.....	1.5	1.5	1.6	1.5
Teacher Preparation and Enhancement.....	1.7	1.5	1.7	1.6
Studies and Program Assessment.....	0.1	0.1	0.1	0.1
College Science Instrumentation.....	0.3	0.3	0.4	0.5
Subtotal, Science and Engineering Education.....	5.4%	5.1%	5.6%	5.3%
Special Foreign Currency.....	0.2%	0.1%	0.1%	-
TOTAL, NSF.....	100.0%	100.0%	100.0%	100.0%

SUMMARY OF OBLIGATIONS BY MAJOR OBJECT CLASSIFICATION

	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Research and Related Activities					
Personnel and Compensation.....	\$47,283,721	\$45,720,000	\$47,465,000	\$47,665,000	\$200,000
Personnel Benefits.....	5,117,081	4,661,000	5,066,000	5,155,000	89,000
Travel and Transportation of Persons...	2,919,530	3,000,000	3,450,000	3,500,000	50,000
Transportation of Things.....	319,211	295,000	295,000	245,000	-50,000
Rents and Communications.....	7,763,646	8,085,300	8,085,300	10,755,000	2,669,700
Printing and Reproduction.....	442,687	435,000	435,000	420,000	-15,000
Other Contractual Services:					
Program Contracts.....	162,374,004	197,850,000	167,667,000	184,389,000	16,722,000
Prog. Devel. & Mgt. Contract Services.	4,226,310	3,877,900	3,877,900	5,611,000	1,733,100
Supplies and Materials.....	934,489	709,800	709,800	959,000	249,200
Equipment.....	2,908,939	3,086,000	3,086,000	3,660,000	574,000
Grants, Subsidies and Contributions:					
Program Grants.....	1,077,139,026	1,130,000,000	1,112,234,968	1,216,611,000	104,376,032
Program Development and Management					
Grants.....	15,656	30,000	30,000	30,000	-0-
Subtotal, Research & Related Activities....	1,311,444,300	1,387,750,000	1,352,401,968	1,479,000,000	126,598,032
U.S. Antarctic Program					
Program Contracts.....	100,449,545	107,600,000	104,369,068	106,125,000	1,755,932
Program Grants.....	10,391,040	12,500,000	10,790,100	10,875,000	84,900
Subtotal, U.S. Antarctic Program.....	110,840,585	120,100,000	115,159,168	117,000,000	1,840,832
Science and Engineering Education					
Program Contracts.....	2,213,434	3,000,000	2,244,154	2,700,000	455,846
Program Grants.....	79,742,385	79,000,000	84,800,171	86,350,000	1,499,829
Subtotal, Science and Engineering Education.....	81,955,819	82,000,000	87,044,325	89,000,000	1,955,675
Special Foreign Currency					
Travel & Transportation of Persons.....	81,586	200,000	62,254	40,000	-22,254
Program Contracts.....	233,615	150,000	89,735	80,000	-9,735
Program Grants.....	2,514,304	650,000	850,428	580,000	-270,428
Subtotal, Special Foreign Currency.....	2,829,505	1,000,000	1,002,417	700,000	-302,417
TOTAL, NSF.....	\$1,507,070,209	\$1,600,850,000	\$1,555,607,876	\$1,685,700,000	\$130,092,122

NSF APPROPRIATION LANGUAGE**RESEARCH AND RELATED ACTIVITIES**

For necessary expenses in carrying out the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), title IX of the National Defense Education Act of 1958 (42 U.S.C. 1876-1879), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of one aircraft; hire of passenger motor vehicles; not to exceed [\$2,500] \$4,000 for official reception and representation expenses; uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901-5902); rental of conference rooms in the District of Columbia; and reimbursement of the General Services Administration for security guard services; [\$1,352,205,000], \$1,479,000,000 to remain available until September 30, [1987] 1988: *Provided*, That of the funds appropriated in this Act, [or from funds appropriated previously to the Foundation,] not more than [\$72,500,000] \$78,000,000 shall be available for program development and management in fiscal year [1986] 1987, [including \$3,450,000 for expenses of travel]: *Provided further*, That contracts may be entered into under the program development and management limitation in fiscal year [1986] 1987 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation: *Provided further*, That to the extent that the amount appropriated is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally, [*Provided further*, That not to exceed \$9,000,000 shall be available for the very long baseline array: *Provided further*, That the Foundation is hereafter authorized to indemnify grantees, contractors, and subcontractors associated with the ocean drilling program under the provisions of section 2354 of title 10 of the United States Code, with all approvals and certifications required thereby made by the Director of the National Science Foundation].

(Department of Housing and Urban Development--Independent Agencies Appropriation Act, 1986; additional authorizing legislation to be proposed.)

UNITED STATES ANTARCTIC PROGRAM ACTIVITIES

For necessary expenses in carrying out the research and operational support for the United States Antarctic Program pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); maintenance and operation of aircraft and purchase of flight services for research and operations support; maintenance and operation of research ships and charter or lease of ships for research and operations support; hire of passenger motor vehicles; not to exceed \$1,000 for official reception and representation expenses; [\$115,100,000] \$117,000,000, to remain available until expended: *Provided*, That receipts for support services and materials provided to individuals for non-Federal activities may be credited to this appropriation: *Provided further*, That no funds in this account shall be used for the purchase of aircraft.

(Department of Housing and Urban Development--Independent Agencies Appropriation Act, 1986; additional authorizing legislation to be proposed.)

NSF APPROPRIATION LANGUAGE, continuedSCIENCE AND ENGINEERING EDUCATION ACTIVITIES

For necessary expenses in carrying out science and engineering education programs and activities pursuant to the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including award of graduate fellowships, services as authorized by 5 U.S.C. 3109, and rental of conference rooms in the District of Columbia, [\$55,550,000] \$89,000,000, to remain available until September 30, [1987] 1988: *Provided*, That to the extent that the amount of this appropriation is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally.

(Department of Housing and Urban Development--Independent Agencies Appropriation Act, 1986; additional authorizing legislation to be proposed.)

SCIENTIFIC ACTIVITIES OVERSEAS (SPECIAL FOREIGN CURRENCY PROGRAM)

For payments in foreign currencies which the Treasury Department determines to be excess to the normal requirements of the United States, for scientific activities, as authorized by law, [\$1,000,000] \$700,000, to remain available until September 30, [1987] 1988: *Provided*, That this appropriation shall be available in addition to other appropriations to the National Science Foundation for payments in the foregoing currencies.

(Department of Housing and Urban Development--Independent Agencies Appropriation Act, 1986; additional authorizing legislation to be proposed.)

GRAMM-RUDMAN-HOLLINGS IMPACT

The following table displays the amended current plan for FY 1986 that will result if the sequestration provisions of Public Law 99-177, *The Balanced Budget and Emergency Deficit Control Act of 1985* are activated.

In accordance with the directions of the HUD - Independent Agencies Subcommittees, the specified reduction of 4.3% has been applied equally to each program, project, activity and subactivity contained in the FY 1986 budget justification, as subsequently modified by Congressional acts and reports.

Any changes from this revised plan will be presented to the Subcommittees in the usual fashion should reprogramming prove necessary or desirable.

GRAMM-RUDMAN-HOLLINGS IMPACT

PROGRAM ELEMENT	CURRENT PLAN FOR FY 1986	GRAMM-RUDMAN- HOLLINGS REDUCTION	NET FY 1986
MATHEMATICAL AND PHYSICAL SCIENCES			
MATHEMATICAL SCIENCES			
Classical Analysis.....	\$5,015,000	\$215,645	\$4,799,355
Modern Analysis.....	5,090,000	218,870	4,871,130
Geometric Analysis.....	4,951,000	212,893	4,738,107
Topology and Foundations.....	6,161,000	264,923	5,896,077
Algebra and Number Theory.....	8,581,000	368,983	8,212,017
Applied Mathematics.....	7,030,000	302,290	6,727,710
Statistics and Probability.....	6,170,000	265,310	5,904,690
Special Projects.....	8,742,000	375,906	8,366,094
Total.....	51,740,000	2,224,820	49,515,180
COMPUTER RESEARCH			
Theoretical Computer Science.....	5,150,000	221,450	4,928,550
Software Systems Science.....	4,800,000	206,400	4,593,600
Software Engineering.....	3,850,000	165,550	3,684,450
Intelligent Systems.....	5,350,000	230,050	5,119,950
Computer Systems Design.....	3,500,000	150,500	3,349,500
Coordinated Experimental Research.....	15,100,000	649,300	14,450,700
Special Projects.....	920,000	39,560	880,440
Computer Research Equipment.....	1,500,000	64,500	1,435,500
Total.....	49,170,000	1,727,310	47,442,690
PHYSICS			
Elementary Particle Physics.....	42,130,000	1,011,590	40,318,410
Intermediate Energy Nuclear Physics.....	18,800,000	808,400	17,991,600
Nuclear Physics.....	21,600,000	920,800	20,679,200
Atomic, Molecular, and Plasma Physics.....	13,700,000	589,100	13,110,900
Theoretical Physics.....	14,400,000	619,200	13,780,800
Gravitational Physics.....	8,000,000	344,000	7,656,000
Total.....	118,630,000	5,101,090	113,528,910
CHEMISTRY			
Structural Chemistry and Thermodynamics.....	15,537,000	668,091	14,868,909
Chemical Physics.....	14,902,000	640,786	14,261,214
Chemical Dynamics.....	15,966,000	686,538	15,279,462
Chemical Analysis.....	11,345,000	487,835	10,857,165
Synthetic Inorganic and Organometallic Chemistry.....	9,470,000	407,210	9,062,790
Synthetic Organic and Natural Products Chemistry.....	10,950,000	470,850	10,479,150
Chemical Instrumentation.....	11,610,000	499,230	11,110,770
Total.....	89,780,000	3,860,340	85,919,660
MATERIALS RESEARCH			
Solid State Physics.....	11,885,000	511,055	11,373,945
Solid State Chemistry.....	8,662,000	372,466	8,289,534
Low Temperature Physics.....	8,178,000	351,654	7,826,346
Condensed Matter Theory.....	8,502,000	365,586	8,136,414
Metallurgy.....	9,810,000	421,830	9,388,170
Ceramics and Electronic Materials.....	6,597,000	283,671	6,313,329
Polymers.....	7,121,000	306,203	6,814,797
Instrumentation for Materials Research, Materials Research Laboratories.....	6,245,000	268,535	5,976,465
National Facilities.....	27,200,000	1,169,600	26,030,400
National Facilities.....	10,650,000	457,950	10,192,050
Materials Research Groups.....	4,800,000	206,400	4,593,600
Total.....	109,650,000	4,714,950	104,935,050
TOTAL, NPS.....	409,870,000	17,628,710	392,241,290

GRAMM-RUDMAN-HOLLINGS IMPACT - continued

PROGRAM ELEMENT	CURRENT PLAN FOR FY 1986	GRAMM-RUDMAN HOLLINGS REDUCTION	NEW FY 1986
ENGINEERING			
ENGINEERING SCIENCE IN CHEMICAL, BIOCHEMICAL, AND THERMAL ENGINEERING			
Kinetics and Catalysis Engineering.....	\$3,100,000	\$133,300	\$2,966,700
Biochemical and Biomass Engineering.....	3,030,000	130,290	2,899,710
Process and Reaction Engineering.....	3,450,000	148,350	3,301,650
Multiphase and Interfacial Phenomena.....	3,400,000	146,200	3,253,800
Separation and Purification Processes....	3,100,000	133,300	2,966,700
Thermodynamics and Transport Phenomena...	4,400,000	197,800	4,202,200
Thermal Systems and Engineering.....	8,500,000	365,500	8,134,500
Total.....	29,180,000	1,256,740	27,923,260
ENGINEERING SCIENCE IN MECHANICS, STRUCTURES, AND MATERIALS ENGINEERING			
Solid and Geomechanics.....	6,100,000	262,300	5,837,700
Structures and Building Systems.....	3,900,000	167,700	3,732,300
Fluid Dynamics and Hydraulics.....	5,600,000	240,800	5,359,200
Tribology.....	2,000,000	86,000	1,914,000
Dynamic Systems and Control.....	2,800,000	120,400	2,679,600
Materials Engineering and Processing.....	3,300,000	141,900	3,158,100
Total.....	23,700,000	1,019,100	22,680,900
ENGINEERING SCIENCE IN ELECTRICAL, COMMUNICATIONS, AND SYSTEMS ENGINEERING			
Solid State and Microstructures.....	7,200,000	309,600	6,890,400
Communications Systems and Signal Processing.....	5,300,000	227,900	5,072,100
Systems Theory and Operations Research....	5,200,000	223,600	4,976,400
Quantum Electronics, Waves and Beams....	4,900,000	210,700	4,689,300
Instrumentation, Sensing and Measurement..	3,100,000	133,300	2,966,700
Total.....	25,700,000	1,105,100	24,594,900
SCIENCE BASE DEVELOPMENT IN DESIGN, MANUFACTURING, AND COMPUTER ENGINEERING			
Computer Engineering.....	5,700,000	245,100	5,454,900
Design Theory and Methodology.....	2,800,000	120,400	2,679,600
Computer Integrated Engineering.....	2,000,000	86,000	1,914,000
Manufacturing Systems.....	5,100,000	219,300	4,880,700
Automation and Systems Integration.....	3,100,000	133,300	2,966,700
Total.....	18,700,000	804,100	17,895,900
FUNDAMENTAL RESEARCH FOR EMERGING AND CRITICAL ENGINEERING SYSTEMS			
Biotechnology.....	3,000,000	129,000	2,871,000
Bioengineering and Research for the Handicapped.....	4,700,000	202,100	4,497,900
Lightwave Technology.....	3,000,000	129,000	2,871,000
Earthquake Hazard Mitigation.....	15,700,000	675,100	15,024,900
Environmental Engineering.....	4,365,000	187,695	4,177,305
Systems Engineering for Large Structures..	2,900,000	124,700	2,775,300
Natural and Man-Made Hazard Mitigation...	2,530,000	108,790	2,421,210
Total.....	36,195,000	1,556,595	34,638,405
CROSS-DISCIPLINARY RESEARCH			
Engineering Research Centers.....	23,000,000	969,000	22,031,000
Industry/University Research Projects.....	3,000,000	129,000	2,871,000
Industry/University Research Centers.....	3,000,000	129,000	2,871,000
Total.....	29,000,000	1,227,000	27,773,000
TOTAL, ENGINEERING.....	162,475,000	6,906,425	155,568,575

GRAMM-RUDMAN-HOLLINGS IMPACT - continued,

PROGRAM ELEMENT	CURRENT PLAN FOR FY 1986	GRAMM-RUDMAN HOLLINGS REDUCTION	NET FY 1986
BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES			
MOLECULAR BIOSCIENCES			
Biological Instrumentation.....	\$8,300,000	\$356,900	\$7,943,100
Biochemistry.....	15,130,000	630,590	14,499,410
Biophysics.....	14,700,000	632,100	14,067,900
Prokaryotic Genetics.....	8,800,000	378,400	8,421,600
Metabolic Biology.....	15,000,000	845,000	14,155,000
Total.....	61,930,000	2,662,990	\$9,267,010
CELLULAR BIOSCIENCES			
Cell Biology.....	11,200,000	481,600	10,718,400
Cellular Physiology.....	8,100,000	348,300	7,751,700
Developmental Biology.....	14,010,000	602,430	13,407,570
Eukaryotic Genetics.....	9,040,000	388,720	8,651,280
Regulatory Biology.....	9,780,000	420,540	9,359,460
Total.....	52,130,000	2,241,590	49,888,410
BIOTIC SYSTEMS AND RESOURCES			
Ecology.....	9,731,900	418,472	9,313,428
Ecosystem Studies.....	18,687,440	803,560	17,883,880
Systematic Biology.....	12,611,000	542,273	12,068,727
Population Biology and Physiological Ecology.....	10,329,000	444,147	9,884,853
Biological Research Resources.....	9,660,660	415,408	9,245,252
Total.....	61,020,000	2,623,860	\$8,396,140
BEHAVIORAL AND NEURAL SCIENCES			
Anthropology.....	7,300,000	313,900	6,986,100
Linguistics.....	3,150,000	135,450	3,014,550
Memory and Cognitive Processes.....	4,000,000	172,000	3,828,000
Social and Developmental Psychology.....	3,150,000	135,450	3,014,550
Developmental Neuroscience.....	3,550,000	238,650	3,311,350
Integrative Neural Systems.....	5,100,000	219,300	4,880,700
Molecular and Cellular Neurobiology.....	3,550,000	238,650	3,311,350
Psychobiology.....	4,730,000	203,390	4,526,610
Sensory Physiology and Perception.....	7,160,000	307,880	6,852,120
Total.....	45,690,000	1,964,670	43,725,330
SOCIAL AND ECONOMIC SCIENCE			
Economics.....	12,000,000	516,000	11,484,000
Geography.....	1,600,000	68,800	1,531,200
Sociology.....	3,700,000	159,100	3,540,900
Measurement Methods and Data Improvement.....	3,700,000	159,100	3,540,900
History and Philosophy of Science.....	1,620,000	69,660	1,550,340
Political Science.....	3,700,000	159,100	3,540,900
Law and Social Sciences.....	1,620,000	69,660	1,550,340
Decision and Management Science.....	2,100,000	90,300	2,009,700
Total.....	30,040,000	1,281,720	28,758,280
INFORMATION SCIENCE AND TECHNOLOGY			
Information Science.....	5,370,000	230,910	5,139,090
Information Technology.....	1,945,000	83,635	1,861,365
Information Impact.....	1,945,000	83,635	1,861,365
Total.....	9,260,000	398,180	8,861,820
TOTAL, RRS.....	260,070,000	11,193,610	248,876,390

GRAMM-RUDMAN-HOLLINGS IMPACT - continued,

PROGRAM ELEMENT	CURRENT PLAN NOA FY 1966	GRAMM-RUDMAN HOLLINGS REDUCTION	NET FY 1966
ASTRONOMICAL, ATMOSPHERIC, EARTH, AND OCEAN SCIENCES			
ASTRONOMICAL SCIENCES			
Astronomy Project Support.....	27,610,000	1,187,230	26,422,770
National Astronomy and Ionosphere Center.....	6,150,000	264,430	5,885,550
National Optical Astronomy Observatories.....	23,800,000	1,023,400	22,776,600
National Radio Astronomy Observatory.....	26,660,000	1,146,380	25,513,620
Total.....	84,220,000	3,621,460	80,598,540
ATMOSPHERIC SCIENCES			
Atmospheric Sciences Project Support....	49,415,000	2,124,845	47,290,155
National Center for Atmospheric Research.....	43,135,000	1,854,805	41,280,195
Upper Atmospheric Facilities.....	4,230,000	181,890	4,048,110
Total.....	96,780,000	4,161,540	92,618,460
EARTH SCIENCES			
Stratigraphy and Paleontology.....	3,800,000	163,400	3,636,600
Surficial Processes.....	2,900,000	124,700	2,775,300
Crustal Structure and Tectonics.....	3,900,000	167,700	3,732,300
Seismology.....	4,600,000	197,800	4,402,200
Experimental and Theoretical Geophysics..	4,900,000	210,700	4,689,300
Petrogenesis and Mineral Resources.....	4,000,000	172,000	3,828,000
Volcanology and Mantle Geochemistry.....	3,700,000	159,100	3,540,900
Experimental and Theoretical Geochemistry	6,000,000	258,000	5,742,000
Instrumentation and Facilities.....	5,000,000	215,000	4,785,000
Continental Lithosphere.....	10,140,000	436,020	9,703,980
Total.....	48,940,000	2,104,420	46,835,580
OCEAN SCIENCES			
Ocean Sciences Research Support.....	59,956,000	2,578,108	57,377,892
Oceanographic Center and Facilities.....	35,224,000	1,514,632	33,709,368
Ocean Drilling Program.....	28,850,000	1,240,550	27,609,450
Total.....	124,030,000	5,333,290	118,696,710
ARCTIC RESEARCH PROGRAM			
Arctic Research Projects.....	8,220,000	353,460	7,866,540
Arctic Research Commission.....	300,000	12,900	287,100
Total.....	8,520,000	366,360	8,153,640
TOTAL AARO.....	362,490,000	15,597,070	346,892,930

GRAMM-RUDMAN-HOLLINGS IMPACT - continued,

PROGRAM ELEMENT	CURRENT PLAN NOA FY 1986	GRAMM-RUDMAN HOLLINGS REDUCTION	NET FY 1986
SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS			
INDUSTRIAL SCIENCE AND TECHNOLOGICAL INNOVATION			
Small Business Innovation Research.....	\$15,650,000	\$672,950	\$14,977,050
Productivity Improvement Research.....	110,000	4,730	105,270
Total.....	15,760,000	677,680	15,082,320
INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES			
International Cooperative Science.....	10,140,000	436,020	9,703,980
International Scientific Organizations and Resources.....	700,000	30,100	669,900
Total.....	10,840,000	466,120	10,373,880
POLICY RESEARCH AND ANALYSIS			
Policy Research and Analysis.....	1,940,000	83,420	1,856,580
Total.....	1,940,000	83,420	1,856,580
SCIENCE RESOURCES STUDIES			
Scientific and Technical Personnel.....	2,090,000	89,870	2,000,130
Funding of Science and Technology.....	1,250,000	53,750	1,196,250
Modeling and Special Science and Technology Indicators.....	600,000	25,800	574,200
Total.....	3,940,000	169,420	3,770,580
RESEARCH INITIATION AND IMPROVEMENT			
Visiting Professorships for Women.....	2,000,000	86,000	1,914,000
Research Improvement in Minority Institutions.....	4,990,000	214,570	4,775,430
Total.....	6,990,000	300,570	6,689,430
TOTAL, STIA.....	39,470,000	1,697,210	37,772,790
ADVANCED SCIENTIFIC COMPUTING.....	\$45,230,000	\$1,944,890	\$43,285,110
PROGRAM DEVELOPMENT AND MANAGEMENT.....	872,500,000	83,117,500	869,382,500
TOTAL, RESEARCH AND RELATED ACTIVITIES	\$1,352,205,000	\$50,144,815	\$1,294,060,185

GRAMM-RUDMAN-HOLLINGS IMPACT - continued,

PROGRAM ELEMENT	CURRENT PLAN NOA FY 1986	GRAMM-RUDMAN HOLLINGS REDUCTION	NET FY 1986
U.S. ANTARCTIC PROGRAM			
U.S. ANTARCTIC RESEARCH PROGRAM, Total....	11,500,000	494,500	11,005,500
OPERATIONS SUPPORT PROGRAM			
Direct Science Support.....	15,300,000	657,900	14,642,100
Base Level Support.....	70,000,000	3,010,000	66,990,000
Major Construction and Procurement.....	10,300,000	786,900	17,513,100
Total.....	103,600,000	4,454,800	99,145,200
TOTAL, USAF.....	115,100,000	4,949,300	110,150,700
SCIENCE AND ENGINEERING EDUCATION			
Research Career Development.....	\$27,300,000	\$1,173,900	\$26,126,100
Materials Development, Research, and Informal Science Education.....	9,250,000	397,750	8,852,250
Teacher Preparation and Enhancement.....	11,500,000	494,500	11,005,500
Studies and Program Assessment.....	2,000,000	86,000	1,914,000
College Science Instrumentation.....	3,500,000	236,500	3,263,500
Total.....	\$55,550,000	\$2,388,650	\$53,161,350
SPECIAL FOREIGN CURRENCY.....	1,000,000	43,000	957,000
TOTAL, NATIONAL SCIENCE FOUNDATION.....	\$1,523,855,000	\$65,525,765	\$1,458,329,235

MATHEMATICAL AND PHYSICAL SCIENCES.....\$449,250,000**SUMMARY OF REQUEST**

The requested increase is \$39.3 million or 9.6% over the FY 1986 Current Plan of \$410.0 million.

Subactivity	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
I. Mathematical Sciences.....	547,729,804	\$54,690,000	\$51,740,000	\$59,800,000	\$8,060,000
II. Computer Research.....	39,124,447	41,730,000	40,170,000	44,440,000	4,270,000
III. Physics.....	115,795,000	123,370,000	118,630,000	126,640,000	8,010,000
IV. Chemistry.....	87,563,306	93,500,000	89,780,000	101,020,000	11,240,000
V. Materials Research.....	106,575,510	115,680,000	109,650,000	117,350,000	7,700,000
TOTAL, MPS	\$397,188,087	\$428,970,000	\$409,970,000	\$449,250,000	\$39,280,000

NSF ROLE

The Mathematical and Physical Sciences (MPS) Activity develops, at the most fundamental level, an understanding of the physical laws governing the world in which we live and ensures that our Nation's future scientists and mathematicians receive the best training in the world.

Achieving these goals is essential to the future academic, industrial, and defense needs of the United States. Research in mathematics, computer research, physics, chemistry and material science underlies the knowledge for future technological developments upon which our economic and social well-being depend and -- because the research is conducted at colleges and universities -- simultaneously serves to train future scientists.

MPS disciplines support individual and group research projects, special instrumentation, university research laboratories, and national user facilities. Support is focused in the Nation's colleges and universities because they combine forefront research with advanced training of post-graduate students. Except for mathematics, the MPS disciplines are based on experimental research and, therefore, an adequate experimental capability is paramount. Thus, MPS emphasizes provision of modern research equipment, together with the associated technical support and necessary maintenance.

There is an increasing need for more centralized, major research instrumentation. Consequently, support is provided for a variety of university laboratories, such as several low energy cyclotron and Van de Graaf accelerator laboratories in nuclear physics, interdisciplinary Materials Research Laboratories, and coordinated experimental facilities in computer research.

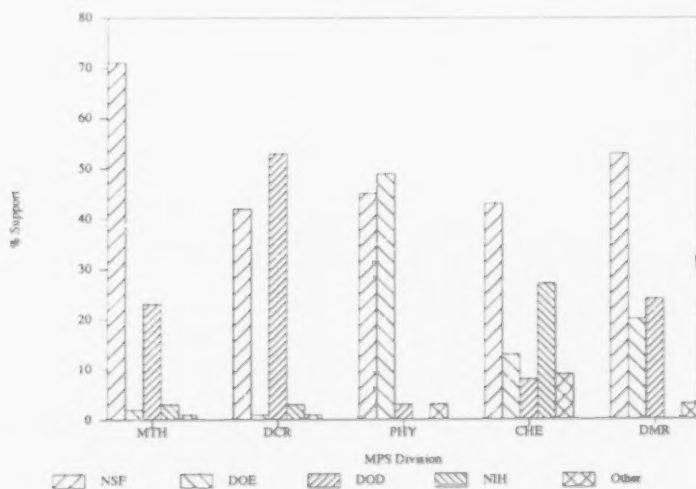
In order to make major experimental or intellectual resources available to the broad scientific community a number of national user facilities also are maintained. These include, for example, the Cornell Electron Storage Ring (CESR); synchrotron radiation facilities at the University of Wisconsin and Cornell University; and the mathematical sciences research institutes at Berkeley and Minnesota.

Research in the mathematical and physical sciences is strongly interactive; results in one area often have important applications to research in another. The new Materials Research Group program responds to this trend by emphasizing collaborative research projects intermediate in scope between individual projects and the Materials Research Laboratories. Such collaborative efforts are further strengthened by their dependence on shared instrumentation such as computers, lasers and nuclear magnetic resonance spectrometers.

Use of advanced computers as an adjunct to theoretical and experimental research to attack new research frontiers is increasingly important. New insights and approaches are possible in fields such as chemistry and physics as a result of recent advances in computing, mathematical modeling, and algorithm development. With the increased access by the U.S. academic community to supercomputers -- and the tremendous need for scientists and mathematicians trained in the use of these machines -- we are on the threshold of a new era in science. MPS disciplines were key to this development and will continue to play a critical role in the future.

Other Federal agencies also support academic research in the MPS disciplines, but in contrast to NSF, they focus on areas of mission relevance. Figure 1 illustrates this fact; for example, while NIH is a significant supporter of academic chemistry, it is of negligible importance to the other MPS areas.

NSF ROLE



NSF responds to major shifts in funding trends by the other agencies in a way that guards the overall health of U.S. science. Every effort is made to maintain the essential continuity and broad support base of the research and to avoid blunting planned mission agency emphases. In FY 1985, NSF provided about 50 percent of the total Federal support of \$830 million for academic-based research in the MPS disciplines.

Coordination with other agencies is important. Typically, coordination is carried out through interagency coordinating committees. Each MPS subactivity has participants in such committees, which consist of program officials from all relevant Federal agencies. The larger programs, however, require more extensive and formal approaches to interagency coordination. Planning and coordination in elementary particle physics are carried out in the Department of Energy (DOE) High Energy Physics Advisory Panel (HEPAP), in which NSF actively participates. In nuclear science, this function is performed by the joint NSF-DOE Nuclear Science Advisory Committee (NSAC). Effective cooperation with the Department of Defense has also been established for the experimental computer research facilities and the Computer Science Research Network.

CHANGES BETWEEN FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

The FY 1986 Current Plan of \$409.97 million is 4.4 percent below the FY 1986 Request.

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Mathematical Sciences	\$ 54.69	\$ 51.74	\$ - 2.95	-5.4%
Computer Research....	41.73	40.17	- 1.56	-3.7
Physics.....	123.37	118.63	- 4.74	-3.8
Chemistry.....	93.50	89.78	- 3.72	-4.0
Materials Research ..	115.68	109.65	- 6.03	-5.2
Total.....	\$ 428.97	\$ 409.97	\$ -19.00	-4.4%

These changes resulted from the unspecified congressional decrease of \$19.0 million. The impact of these decreases includes the following:

- o The response to the highly-regarded National Research Council report "Renewing U.S. Mathematics" on the personnel shortage in the U.S. mathematics research community has been limited. Redressing the infrastructure problems in mathematics remains a high NSF priority because mathematics underpins essentially all of science and engineering.
- o With the great practical importance of computer science and the interest it holds for young people, there is increasing need for individual research grants, particularly in theoretical areas. To meet this need significant cutbacks were made in plans for experimental areas (Coordinated Experimental Research Program and equipment).

- o The CESR upgrade is stretched an additional year resulting in a small increase in total estimated cost and a delay in the initiation of new experiments for which CESR is a uniquely qualified, world-class facility.
- o As an initial response to the 1985 National Research Council report "Opportunities in Chemistry", funds for instrumentation and research underpinning biotechnology are increased; a number of other urgent needs could not be addressed within the current plan level.
- o The Materials Research Subactivity is phasing out two Materials Research Laboratories, sustaining the individual grants program, and significantly increasing the Materials Research Group (MRG) program in response to strong community support for the MRG concept.

FY 1987 BUDGET HIGHLIGHTS

(Dollars in Millions)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Mathematical Sciences	\$ 51.74	\$ 59.80	\$ 8.06	15.6%
Computer Research....	40.17	44.44	4.27	10.6
Physics.....	118.63	126.64	8.01	6.8
Chemistry.....	89.78	101.02	11.24	12.5
Materials Research ..	109.65	117.35	7.70	7.0
Total.....	\$409.97	\$449.25	\$39.28	9.6%

The requested new obligational authority makes it possible to:

- o Emphasize (an increase of \$12.0 million or 52% over FY 1986) the critically important area of computational science and engineering. The MPS disciplines are uniquely important in this regard, and each of them is involved. The emphasis would support research on new or improved methods of solving scientific problems using modern computers by (1) encouraging collaborative research between scientists, mathematicians and computer specialists; (2) providing intensive training for advanced students; and (3) providing some of the essential equipment needed to take advantage of the super-computer centers (advanced workstations and graphics terminals).
- o Make significant progress toward rebuilding the personnel base in U.S. mathematics by supporting graduate students and postdoctoral researchers (\$4.0 million increase over FY 1986).
- o Meet some of the rapidly growing opportunities in computer research that are arising from the explosive growth and interest in this field among young people while maintaining a proper balance between support for central experimental facilities (CER and equipment) and individual researchers.

- o Initiate a 5-year program to increase support for major chemical instrumentation, including maintenance and operation associated with new shared instruments. This, plus increases in some key areas, such as the Chemistry of Life Processes, provides a very substantive response to the National Research Council report, "Opportunities in Chemistry."
- o Continue the CESR upgrade and also implement further design and R&D studies in the prototype development of a gravity wave detector.
- o Address complex materials research problems through expansion of the Materials Research Groups Program to \$8.8 million for an increase of 83%.
- o Participate in the Foundation-wide emphasis on broadening participation in the sciences and engineering by providing increased research opportunities for undergraduate faculty and students.

MATHEMATICAL SCIENCES.....\$59,800,000

SUMMARY OF REQUEST

The FY 1987 Budget Request of \$59.8 million for the Mathematics Subactivity represents an increase of 15.6% over the FY 1986 Current Plan.

PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
Classical Analysis.....	\$4,553,824	\$5,355,000	\$5,015,000	\$5,767,000	\$752,000
Modern Analysis.....	4,659,121	5,490,000	5,090,000	5,861,000	771,000
Geometric Analysis.....	4,518,028	5,220,000	4,951,000	5,692,000	741,000
Topology and Foundations.....	5,701,868	6,635,000	6,161,000	7,085,000	924,000
Algebra and Number Theory.....	7,909,851	9,110,000	8,581,000	9,868,000	1,287,000
Applied Mathematics.....	6,417,832	7,640,000	7,030,000	8,907,000	1,877,000
Statistics and Probability.....	5,601,757	6,690,000	6,170,000	7,440,000	1,270,000
Special Projects.....	8,367,523	8,550,000	8,742,000	9,180,000	438,000
Total, Mathematical Sciences...	\$47,729,804	\$56,690,000	\$51,740,000	\$59,800,000	\$8,060,000

SCIENTIFIC OVERVIEW

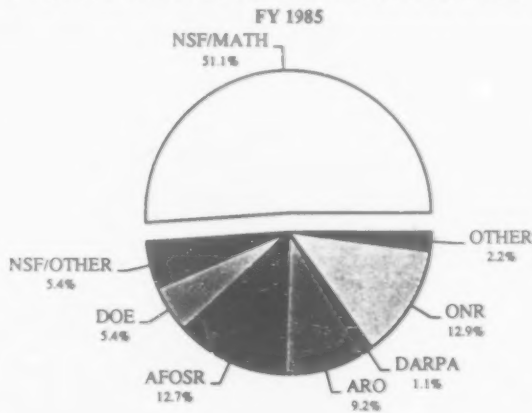
The Mathematical Sciences Subactivity fosters the creation and development of mathematical ideas, methods, and techniques and promotes their use in improving our understanding of physical, biological, engineering, and social phenomena. To achieve these objectives, support provides for significant research in the mathematical sciences, and serves to ensure the continuing vitality and long-range health of the discipline. Each subdiscipline of the mathematical sciences, from those with the sharpest intrinsic focus to those that reach out to other areas of knowledge, is supported in such a way as to encourage their interaction and to provide a healthy balance among them.

The core of the Foundation's program of research support in this area has been the Scientific Research Project Support (SRPS) awards. Within the SRPS activities, significant emphasis has been given to increasing the level of support for the young mathematicians to whom the field owes so much for its vitality. This emphasis has received significant enhancement since FY 1984. The mathematical sciences community recognizes a need for greater opportunities for communication between mathematical scientists in the same or related fields, as well as with scientists in other disciplines. To provide for this need the subactivity has a Special Projects Program which includes funding for research institutes at the University of Minnesota and in Berkeley, California, postdoctoral and visitor support at three other research centers, a program of postdoctoral fellowships, and support for research conferences and workshops. Moreover, researchers are encouraged to join colleagues in obtaining funds for computing equipment that no single project could justify. Activities of this kind will continue to augment the SRPS awards.

During the last few years major structural problems in the support for research in the mathematical sciences have become visible. These problems resulted, in part, from a gradual attrition in support levels over several years. While this attrition was most pronounced in the funding levels for graduate students and postdoctoral associates, it has also affected support for investigators. This problem has been documented in the 1984 report from the National Research Council entitled, *Renewing U.S. Mathematics: Critical Resource for the Future*. As the only Federal agency with responsibility for support of research across the entire spectrum of the mathematical sciences, NSF plays a pivotal role attempting to address these structural problems. The issues are complex, but significant gains have been made since FY 1984. A determined effort, sustained over a period of years, is required to realign support for mathematical sciences research with that of other sciences.

The chart below illustrates the crucial role played by NSF in the Federal support of basic research in the mathematical sciences. Percentages are based on a total Federal expenditure of \$92.86 million in FY 1985. For the past decade, the mission-oriented research agencies have focused their support on applied mathematics and statistics. New programs have been aimed at such emerging fields as dynamical systems and discrete mathematics. In all areas of the mathematical sciences, Foundation-supported research generally involves a broader range of topics than the more project-oriented research sponsored by the mission agencies.

FEDERAL ACADEMIC MATHEMATICS FUNDING



NSF coordinates its support of research in the mathematical sciences with its counterpart Federal agencies through the Interagency Committee for Extramural Mathematics Programs. This group meets regularly to share information on policies of support and to discuss areas of emphasis and of unusual scientific opportunity. Extensive day-to-day contact between program officers at various Federal agencies is maintained by telephone and personal visits. Conferences, workshops, and activities at research centers are sometimes supported jointly by the Foundation and one or more of the other agencies.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Classical Analysis.....	\$5.36	\$ 5.02	\$-0.34	-6.3%
Modern Analysis.....	5.49	5.09	-0.40	-7.3
Geometric Analysis.....	5.22	4.95	-0.27	-5.2
Topology & Foundations..	6.63	6.16	-0.47	-7.1
Algebra & Number Theory.	9.11	8.58	-0.53	-5.8
Applied Mathematics.....	7.64	7.03	-0.61	-8.0
Statistics & Probability	6.69	6.17	-0.52	-7.8
Special Projects.....	8.55	8.74	+0.19	+2.2
TOTAL, Subactivity....	\$54.69	\$51.74	\$-2.95	-5.4%

The FY 1986 Current Plan is 5.4% below the FY 1986 Budget Request. This decrease results from the unspecified Congressional reduction. The decrease was distributed across the programs in accordance with perceived opportunities and needs. The modest increase in special projects reflects adjustments in support of postdoctoral researchers and equipment.

The FY 1986 Current Plan maintains the Foundation's increases in the support of graduate students and postdoctoral researchers at somewhat more modest levels than originally planned. Where possible, these increases are located in the SRPS programs. The table below describes the position with respect to critical infrastructure items. Maintaining progress on the personnel aspects of the infrastructure was held to have the highest priority. Within the senior investigator category, the emphasis will be on younger investigators. The increase for equipment and access to computers is small in dollars but large in percentage. The increase reflects increasing use of computational equipment in all areas of the mathematical sciences.

	<i>FY 1985 Actual</i>	<i>FY 1986 Budget Request</i>	<i>FY 1986 Current Plan</i>	<i>% Increase FY 86 CP/ FY 85 CP</i>
Graduate Students	\$ 6,035,000	\$ 8,600,000	\$ 7,250,000	20.1%
Postdoctoral Researchers.....	\$6,227,000	\$7,600,000	\$7,002,000	12.5%
SRPS Senior Investigators	\$30,033,000	\$32,380,000	\$32,048,000	6.7%
Equipment/Access.....	\$1,722,000	\$2,780,000	\$2,190,000	27.2%

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

<i>Program Element</i>	<i>FY 1986 Current Plan</i>	<i>FY 1987 Request</i>	<i>Change</i>	
			<i>Amount</i>	<i>Percent</i>
Classical Analysis.....	\$ 5.02	\$ 5.77	\$ 0.75	14.9%
Modern Analysis.....	5.09	5.86	0.77	15.1
Geometric Analysis.....	4.95	5.69	0.74	15.0
Topology & Foundations..	6.16	7.08	0.92	14.9
Algebra & Number Theory.	8.58	9.87	1.29	15.0
Applied Mathematics.....	7.03	8.91	1.88	26.7
Statistics & Probability	6.17	7.44	1.27	20.6
Special Projects.....	8.74	9.18	0.44	5.0
TOTAL, Subactivity....	\$51.74	\$59.80	\$ 8.06	15.6%

The increase of 15.6% for the Mathematical Sciences subactivity is partially in response to the recommendations of the recent report from the National Research Council entitled Renewing U.S. Mathematics: Critical Resource for the Future and the subsequent National Science Board resolution on the need to bolster resources for the mathematical sciences. The central role of the mathematical sciences in the computational approach to science and engineering accounts for the remainder of the increase.

The mathematical sciences are engaged in the computational approach to science and engineering in three distinct ways. First, as in most other disciplines, the computer is becoming increasingly important as a tool within the mathematical sciences themselves. Second, mathematical scientists, particularly numerical analysts and computational statisticians, work with scientists and engineers from all disciplines in the integrated development and application of computational mathematical models, algorithms and efficient computational software. Finally, the mathematical sciences provide the necessary theoretical underpinnings for the development of computational methods.

The FY 1987 Budget Request provides \$3.0 million for increased support for all three modes of activity with emphasis on the second. These funds have been distributed across the Subactivity according to expected use. The greater involvement of the programs of Applied Mathematics and Statistics and Probability in the area of computational science and engineering results in larger increases for these programs. Funds associated with this computational initiative will be coordinated on a Subactivity-wide basis, with the development of multidisciplinary teams providing a focus for the research supported.

Since FY 1984, the budget of the Mathematical Sciences subactivity has included increments dedicated to the support of graduate students and postdoctoral associates. This emphasis is continued in the FY 1987 Budget Request. The table below summarizes the impact of the request on various items.

	FY 1986 Current Plan	FY 1987 Budget Request	% Increase FY 1987/ FY 86 CP
Graduate Students ...	\$ 7,250,000	\$ 9,900,000	36.6%
Postdoctoral Researchers.....	7,002,000	8,060,000	15.1
SRPS Senior Investigators	32,048,000	35,620,000	11.1
Equipment/Access.....	2,190,000	2,850,000	30.1

- o All support for graduate students will be located in the SRPS programs. The number of graduate students supported will increase from about 750 in FY 1986 to about 875 in FY 1987, and more of the students will be supported as full-time research assistants.
- o The increase in funds for postdoctoral researchers will come almost entirely in the SRPS programs. The number of Mathematical Sciences Postdoctoral Research Fellowships awarded by the Special Projects Program will be held constant at 30. The total number of postdoctoral researchers supported is expected to increase from about 240 in FY 1986 to about 255 in FY 1987 while the time supported per postdoctoral researcher increases significantly on SRPS awards.

- o Funds for the support of senior investigators include support for the Mathematical Sciences aspects of Foundation-wide activities such as the Presidential Young Investigator awards, Research Opportunities for Women, Research in Undergraduate Institutions, Minority Research Initiation, and the Experimental Program to Stimulate Competitive Research. It is expected that the number of investigators supported will increase from about 1300 in FY 1986 to about 1330 in FY 1987.
- o The increase for computer equipment and access to computing facilities is large in percentage, but small in amount. The increase is in response to the increasing need for this resource in all of the areas of the mathematical sciences.

COMPUTER RESEARCH \$ 44,440,000**SUMMARY OF REQUEST**

Support for Computer Research is increased by \$4.27 million, or 10.6%.

PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
Theoretical Computer Science.....	\$ 4,857,972	\$ 4,750,000	\$ 5,150,000	\$ 5,580,000	\$ 430,000
Software Systems Science.....	4,239,998	4,400,000	4,800,000	5,470,000	670,000
Software Engineering.....	3,574,214	3,850,000	3,850,000	4,930,000	1,080,000
Intelligent Systems.....	5,221,661	5,400,000	5,350,000	5,670,000	320,000
Computer Systems Design.....	3,601,724	4,180,000	3,500,000	3,470,000	(30,000)
Coordinated Experimental Research.....	15,116,993	16,300,000	15,100,000	14,400,000	(700,000)
Special Projects.....	1,018,290	1,060,000	920,000	3,420,000	2,500,000
Computer Research Equipment.....	1,491,789	1,790,000	1,500,000	1,500,000	0
Total, Computer Research	\$39,124,447	\$41,730,000	\$40,170,000	\$44,440,000	\$4,270,000

SCIENTIFIC OVERVIEW

The new academic discipline of computer research has its roots in the mathematical sciences, electrical engineering, and logic. The use of computers stimulates the growth of computer research as a discipline; in turn, computer research is building the knowledge base for improving computer technology. Unlike the physical sciences, which deal with the intrinsic properties of physical matter, computer research discovers the concepts and laws governing problem-solving procedures and develops computing systems which test and utilize them. The universe for study consists of strategies and algorithms for solving problems, methods of representing and transforming information, programs for carrying out computation procedures, and machines for executing programs.

Funding patterns in computer research are often difficult to discern because it is common to confuse research in other sciences using computers or applied research on computer technology performed by industry or the mission-oriented agencies with computer research. The computer industry, paced by the constant demand for new or improved products, has concentrated on short-term requirements for most research and development projects. Some basic research is carried out, principally in a few of the largest companies, and companies also provide limited support for academic research. This is mainly in the form of discounts or gifts of equipment but there are also some faculty study contracts, graduate student fellowships or forgivable loans, and a small number of unrestricted departmental grants. The total investment by industry at academic institutions has been increasing but there is heavy emphasis on educational use of computers, concentration of research support at a few selected academic centers, and product orientation.

Both academic and industrial computer research are supported by several agencies and, with the Department of Defense Strategic Computing initiative, Federal investment has risen rapidly. Most Federal programs support directed research that is relevant to their respective missions. As with industrial support, there is concentration at a few academic centers on selected topics. In contrast, NSF responds to unsolicited proposals in all areas of computer research from all research performing institutions. As a result, NSF support is more widely distributed in both subject and locale and plays a unique role in discovering knowledge and strengthening the country's scientific potential.

CHANGES BETWEEN THE FY1986 BUDGET REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Theoretical Comp. Sci...	\$4.75	\$ 5.15	\$ 0.40	8.4%
Software Systems Science	4.40	4.80	0.40	9.1
Software Engineering....	3.85	3.85	0.00	0.0
Intelligent Systems.....	5.40	5.35	- 0.05	- 0.9
Computer Systems Design.	4.18	3.50	- 0.68	-16.3
Coordinated Experimental Research.....	16.30	15.10	- 1.20	- 7.4
Special Projects.....	1.06	0.92	- 0.14	-13.2
Computer Research Equip.	1.79	1.50	- 0.29	-16.2
TOTAL, Subactivity....	\$41.73	\$40.17	- \$1.56	- 3.7%

The FY 1986 Current Plan is 3.7% below the FY 1986 Budget Request. This decrease corresponds to the unspecified Congressional Appropriation reduction. This reduction was not spread evenly across the programs. Increased proposal pressure, coupled with identified needs for more support for research in the foundations of computer science and computer engineering, have led to increases in the more theoretical computer research project support programs and a resulting larger decrease in other programs. The priorities are consistent with plans to emphasize standard research project support over infrastructure support, with substantial reductions being made in the Computer Research Equipment, Special Projects, and Coordinated Experimental Research programs. The reduction to the Computer Systems Design Program reflects growing cooperation and joint sponsorship with other NSF programs such as the Computer Engineering Program within the Design, Manufacturing, and Computer Engineering Subactivity and with the programs of other agencies such as DARPA and DOE.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Theoretical Comp. Sci....	\$ 5.15	\$ 5.58	\$ 0.43	8.3%
Software Systems Science	4.80	5.47	0.67	14.0
Software Engineering....	3.85	4.93	1.08	28.1
Intelligent Systems.....	5.35	5.67	0.32	6.0
Computer Systems Design.	3.50	3.47	-0.03	-0.9
Coordinated Experimental Research.....	15.10	14.40	-0.70	-4.6
Special Projects.....	0.92	3.42	2.50	271.7
Computer Research Equip.	1.50	1.50	-0-	0.0
TOTAL, Subactivity....	\$40.17	\$44.44	\$ 4.27	10.6%

The FY 1987 Request is for an increase of \$4.27 million or 10.6%, above the FY 1986 Current Plan.

The Computer Research budget in FY 1987 reflects two new NSF activities.

- o Computational Science and Engineering (\$1.01 million in the Software Engineering Program Element). This will support 3-5 investigator interdisciplinary research groups, advanced computational facilities, and individual research projects to discover computational methods appropriate for new computer architectures.
- o Research on Advanced Computers (\$3.0 million; \$2.0 million in the Special Projects Program Element and \$1.0 million in other program elements). This provides focused resources to study advanced computer concepts and systems. Several areas have been identified that need this type of support including advanced computer architectures, software issues arising from new computer architectures, and information structure, cognition and formal languages. \$3.0 million will enable NSF to make a start toward developing these new research directions. The large project portion of this activity, \$2.0 million, will be administered through the Special Projects Program Element and \$1.0 million will be used to increase the number of smaller faculty and graduate student science research projects in these areas.

Other science research project support will be increased by \$1.46 million, or 6.2%, to a total of \$25.03 million. This will allow limited expansion of support for research on the foundations of computer science and will provide increased support for young faculty and graduate students in all research areas. These items have very high priority in academic computer research at this time.

Because of the extreme need for faculty research projects and graduate student support, the Coordinated Experimental Research Program Element will be reduced by \$0.7 million to \$14.4 million. This will impose a net decrease of one or two in the number of active CER awards. The total number will drop to about 20 or 21 with three or four new or renewal awards replacing the five active awards terminating in FY 1987.

PHYSICS..... \$ 126,640,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request of \$126.64 million is \$8.01 million, or 6.8%, above the FY 1986 Current Plan.

PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
Elementary Particle Physics.....	\$39,777,900	\$44,770,000	\$42,130,000	\$45,690,000	\$3,560,000
Intermediate Energy Nuclear Physics...	18,344,705	18,800,000	18,800,000	18,800,000	0
Nuclear Physics.....	22,992,847	23,400,000	23,600,000	21,220,000	(380,000)
Atomic, Molecular, and Plasma Physics.	13,599,076	13,700,000	13,700,000	13,930,000	230,000
Theoretical Physics.....	13,846,989	14,400,000	14,400,000	15,970,000	1,570,000
Gravitational Physics.....	7,213,483	6,300,000	8,000,000	11,030,000	3,030,000
Total, Physics.....	\$115,795,000	\$123,370,000	\$118,630,000	\$126,640,000	\$8,010,000

SCIENTIFIC OVERVIEW

The Physics subactivity supports the development of new knowledge about the existence, structure, and interactions of the various forms of matter and energy, and about the basic forces that govern these interactions. The ultimate goal is to understand and predict the effects of nature on a scale ranging from the microscopic to the cosmic.

The Physics research program supports a range of activities needed to advance knowledge in the areas of elementary particle physics; nuclear physics; atomic, molecular, and plasma physics; and gravitational physics. Both experimental and theoretical studies are required to produce fuller understanding in each of the areas of interest. A conscious effort is made to support a program that is balanced with respect to the scientific areas as well as to the types of research activities needed for the progress of the field, together with occasional special thrusts for certain fields or for major new projects. Examples of the different types of projects supported include development of new techniques and instrumentation; university-based accelerator laboratories, some of which provide centralized facilities for outside user groups; university-based research groups performing experiments at their own laboratories or at centralized facilities; and theoretical interpretation, exploration, and prediction.

The role of NSF in support of elementary particle and nuclear physics deserves special note because of the apparent dominance of Department of Energy (DOE) support in these fields. In overall Federal support during FY 1985, NSF provided 8 percent and 19 percent, respectively.

The crucial role of NSF shows up in the university component of each, where NSF provides 38 percent of the support for elementary particle physics and 45 percent of the support for nuclear physics university groups and accelerator facilities located at universities. This emphasis on university-based activities in these fields is important to the future science capability of the country, especially with regard to the entry of students into forefront research. The vast majority of experiments at national laboratories is conducted by university groups supported by NSF or DOE.

NSF supports the Cornell Electron Storage Ring (CESR), one of the four national high energy accelerators, and the Indiana University Cyclotron Facility (IUCF) and Michigan State University (MSU) Superconducting Cyclotron, two of the six major national nuclear accelerators. It also supports construction of the MSU higher energy Phase II superconducting cyclotron, which will operate in tandem with the first one when completed. Each of these facilities is unique in its capabilities and provides services unavailable at other laboratories in the United States. The significant role that NSF plays in the support of accelerator development activities is evident in the past successes of the IUCF and CESR. It is also evident in the recommendations for the luminosity and detector upgrade at CESR described in the 1983 report of the Subpanel on New Facilities for the U.S. High Energy Physics Program (of the High Energy Physics Advisory Panel), and in the high priority accorded several NSF-supported nuclear science projects in the national evaluations conducted by the Nuclear Science Advisory Committee.

NSF supports a broad range of extra-nuclear physics, including atomic, molecular, and general physics. Support in certain of these areas is also provided by several other agencies --DOD, DOE, NBS, and NASA. They provide, in total, about twice as much support as NSF; but their support is concentrated in those aspects where the results are of immediate relevance to the agencies' missions. The NSF-funded activities are an important complement that keeps these areas balanced, since the NSF supports work of intrinsic scientific interest allowing long-range and speculative ideas to be investigated. NSF is almost totally responsible for the development and present health of ground-based gravitational physics, a field in which NSF provides about 95 percent of the Federal total. Close attention and coordination are maintained with the programs of the other agencies in all areas supported.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Elementary Particle Phys	\$44.77	\$42.13	\$-2.64	-5.9%
Intermediate Energy				
Nuclear Physics.....	18.80	18.80	0.00	0.0
Nuclear Physics.....	23.40	21.60	-1.80	-7.7
Atomic, Molecular, and Plasma Physics.....	13.70	13.70	0.00	0.0
Theoretical Physics.....	14.40	14.40	0.00	0.0
Gravitational Physics...	8.30	8.00	-0.30	-3.6
TOTAL, Subactivity....	\$123.37	\$118.63	\$-4.74	-3.8%

The FY 1986 Current Plan is 3.8% below the FY 1986 Budget Request as a result of an unspecified Congressional reduction. This reduction is accommodated by delaying funding in the three major areas for which increased facilities funding had been planned:

- o The CESR improvement project will receive \$9.3 million instead of \$12.0 million, a reduction of \$2.70 million.
- o The Nuclear Physics facilities upgrades (Michigan State, Florida State, Rochester, etc) will receive \$2.7 million instead of \$4.5 million, a reduction of \$1.8 million.
- o The planning studies for a large laser interferometer gravitational radiation detector will be increased by \$0.7 million rather than \$1.0 million, a reduction of \$0.3 million.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Elementary Particle Phys	\$42.13	\$45.69	\$ 3.56	8.5%
Intermediate Energy				
Nuclear Physics.....	18.80	18.80	0.00	0.0
Nuclear Physics.....	21.60	21.22	-0.38	-1.8
Atomic, Molecular, and				
Plasma Physics.....	13.70	13.93	0.23	1.7
Theoretical Physics....	14.40	15.97	1.57	10.9
Gravitational Physics...	8.00	11.03	3.03	37.9
TOTAL, Subactivity....	\$118.63	\$126.64	\$ 8.01	6.8%

The FY 1987 Budget Request increase, together with reductions in funding for lower priority or completed projects, allows a continuation and development of some major projects as well as maintenance of the vitality of the base programs.

Two major projects included in the Budget Request are:

- o Continuation of major and comprehensive improvement of the Cornell Electron Storage Ring (CESR) and its associated principal detector facility. An increase of \$3.0 million is projected over the reduced FY 1986 Current Plan amount of \$9.3 million for this project. This implies a stretchout in funding with a one year delay in completion beyond the original FY 1988 date, as well as an increase of \$1.5 million over the expected \$36.1 million total cost.

- o Planning studies and prototype development for possible construction of a laser interferometer system for detection of gravitational waves will be pursued with increased support of \$2.5 million over the FY 1986 level of \$1.7 million. These efforts involve scientists from the California and the Massachusetts Institute of Technology as well as experts from national laboratories and industry.

The various Physics disciplines would maintain the vitality in each program while terminating funding for projects of lower priority. Highlights in the Physics disciplines are:

- o Elementary Particle Physics: Emphasis will be on continuing the instrumentation development for particle detectors to be used with colliding beam facilities at the Cornell Electron Storage Ring, Fermilab, the Stanford Linear Accelerator Center and the European Center for Nuclear Research (CERN). Efforts in non-accelerator particle physics will increase. In particular the Fly's Eye detector, a unique facility at the University of Utah for studying very high energy processes in cosmic rays, will be expanded to improve its capability for detecting gamma rays from luminous sources such as neutron stars.
- o Intermediate Energy Nuclear Physics: Construction funding of the "Cooler" ring at the Indiana University Cyclotron Facility (IUCF) will be completed by late summer of 1987 (\$435,000). IUCF operations and research will increase to \$7.5 million.

At the University of Illinois, research and development for a new high intensity, high duty cycle 450 MeV electron microtron continues at constant effort, including the in-house nuclear physics research with their present lower energy microtron (\$4.5 million).

- o Nuclear Physics: The Michigan State University (MSU) Phase II superconducting cyclotron construction project continues at a level of \$1.5 million. Operations, research and instrumentation of the lower energy (Phase I) superconducting cyclotron increases to \$6.0 million. This funding includes support for outside users as well as nuclear physics research by the in-house staff.

Support will continue at the University accelerator laboratories, which have been reduced in number in past years, with most of the remaining ones having been upgraded in those years. In FY 1987 an additional upgrade at a cost of \$0.5 million will be undertaken, but within an overall support level for these laboratories which drops to \$9.9 million.

- o Atomic, Molecular, & Plasma Physics: The FY 1987 Budget Request maintains this program essentially at the level of the FY 1986 Current Plan. Lower priority projects will be terminated to permit funding of new initiatives. The Joint Institute for Laboratory Astrophysics (JILA) at the University of Colorado will continue at a constant level of \$1.7 million.

- o Theoretical Physics: The base program continues at constant level of effort, with the number of faculty, postdoctorals, and graduate students remaining approximately constant, but with an expected turnover of about 15% to provide new opportunities to the best new researchers. Physics support for the Institute for Theoretical Physics at Santa Barbara will increase to \$1.4 million. When support from the Materials Research Subactivity is included, this total will reach \$1.9 million. An increment of \$1.5 million is provided for new theoretical research activities in Computational Science, to develop new methods in that field.
- o Gravitational Physics: The base program in Gravitational Physics remains constant but an increment of \$0.5 million is provided for Computational Science research in that field.

CHEMISTRY.....\$101,020,000**SUMMARY OF REQUEST**

The FY1987 Budget Request is \$11.24 million, or 12.5% above the FY 1986 Current Plan.

PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
Structural Chemistry and Thermodynamics.....	\$15,020,125	\$15,910,000	\$15,537,000	\$17,140,000	\$ 1,603,000
Chemical Physics.....	14,406,735	15,190,000	14,902,000	16,650,000	1,748,000
Chemical Dynamics.....	15,533,547	15,990,000	15,966,000	17,640,000	1,674,000
Chemical Analysis.....	11,147,208	12,610,000	11,345,000	12,510,000	1,165,000
Synthetic Inorganic and Organometallic Chemistry.....	9,274,483	10,360,000	9,470,000	10,650,000	1,180,000
Synthetic Organic and Natural Products Chemistry.....	10,585,362	11,930,000	10,950,000	12,330,000	1,380,000
Chemical Instrumentation.....	11,535,766	11,510,000	11,610,000	14,100,000	2,490,000
Total, Chemistry	\$87,563,306	\$93,500,000	\$89,780,000	\$101,020,000	\$11,240,000

SCIENTIFIC OVERVIEW

Foundation supported research in chemistry stimulates new discovery and understanding across the entire discipline. This is accomplished through a balanced program of support covering all major subdisciplines of chemistry. These research efforts also assist in providing education and advanced training from undergraduate through postdoctoral levels. This approach fosters interplay between subdisciplines and ensures a healthy balance between experimental and theoretical research.

The Board on Chemical Sciences and Technology of the National Academy of Sciences/National Research Council has completed recently a comprehensive survey, "Opportunities in Chemistry." This major assessment, the first in two decades, outlines contemporary research frontiers of chemistry; the opportunities of chemistry to address society's needs; and the resources needed to advance these frontiers of knowledge and to exploit chemistry's potential to enhance the well-being of humankind. A conclusion of this survey is that priority should be given to the following research frontiers: (a) Understanding Chemical Reactivity; (b) Chemical Catalysis; (c) Chemistry of Life Processes; (d) Chemistry Around Us; and (e) Chemical Behavior Under Extreme Conditions. To facilitate advances in these areas, the report recommends that NSF take steps to increase the support for both shared and dedicated instrumentation and to increase grant sizes.

Recent dramatic progress in chemical instrumentation has been extremely important in breaking new ground in all areas of chemistry. In particular, the incorporation of computers and laser technology into chemical instruments has greatly enhanced the speed and sensitivity of measurements. For the first time, it has led to observation, in intricate detail, of phenomena such as the behavior of molecules on catalyst and electrode surfaces, and inside living cells. It is now possible to observe chemical reactions occurring in less than one-trillionth of a second. The availability of advanced computers has made it possible for theoreticians to perform increasingly accurate calculations using more realistic models. This has resulted in an improved understanding of a variety of phenomena including chemical bonding and reaction mechanisms. Computers are now playing a role in the optimization of reaction yields and the design of new chemical syntheses.

Chemical Synthesis--the construction of molecules--lies at the heart of chemistry. The capabilities of synthetic chemists have improved dramatically during the past decade. A whole new arsenal of synthetic strategies has been developed as a result of intensive interaction between the related subdisciplines of organic chemistry, inorganic chemistry, and chemical dynamics. Synthesis of commercial quantities of important biological regulators, new molecules for the treatment of disease, and substances for incorporation in new materials are challenges that are now being met more effectively as a result of recent fundamental advances in chemistry.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Structural Chemistry and Thermodynamics.....	\$15.91	\$15.54	\$-0.37	-2.3
Chemical Physics.....	15.19	14.90	-0.29	-1.9
Chemical Dynamics.....	15.99	15.97	-0.02	-0.1
Chemical Analysis.....	12.61	11.34	-1.27	-10.0
Synthetic Inorganic and Organometallic Chem...	10.36	9.47	-0.89	-8.6
Synthetic Organic and Natural Products Chem.	11.93	10.95	-0.98	-8.2
Chemical Instrumentation	11.51	11.61	+0.10	+0.9
TOTAL, Subactivity...	\$93.50	\$89.78	\$-3.72	-4.0%

The FY 1986 Current Plan is 4.0 percent below the FY 1986 Budget Request due to the unspecified Congressional reduction. In addition, there is a slight increase in the Chemical Instrumentation Program, \$100,000, reflecting the high priority that is given to shared instrumentation support. These changes have been implemented by reducing support of core

scientific research projects in all of the programs except for Chemical Instrumentation. The relative magnitudes of the reductions have been determined based on actual FY 1985 obligations for each of the programs and current projections of the quality of proposals that will be received by each program during FY 1986. Within each program, research underpinning biotechnology will be continued.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Structural Chemistry and Thermodynamics.....	\$15.54	\$17.14	\$ 1.60	10.3%
Chemical Physics.....	14.90	16.65	1.75	11.7
Chemical Dynamics.....	15.97	17.64	1.67	10.5
Chemical Analysis.....	11.34	12.51	1.17	10.3
Synthetic Inorganic and Organometallic Chem...	9.47	10.65	1.18	12.5
Synthetic Organic and Natural Products Chem.	10.95	12.33	1.38	12.6
Chemical Instrumentation	11.61	14.10	2.49	21.5
TOTAL, Subactivity....	\$89.78	\$101.02	\$11.24	12.5%

The FY 1987 Budget Request is 12.5% above the FY 1986 Current Plan. The requested program increments will continue the planned development of initiatives established in FY 1985 and FY 1986 and reorient some ongoing activities to reflect changing trends and new opportunities.

- o Reductions in Lower Priority Activities. There will be a deemphasis on individual studies that, while of high quality, have limited impact on new synthetic methodologies, analytical approaches, or technological innovations.
- o Shared Instrumentation. A five-year program to increase support for major chemical instrumentation will be initiated at a level of \$3.0 million. The international competitiveness of academic chemistry departments depends critically on access to state-of-the-art instrumentation. In the past, the Chemistry Subactivity has provided funding for the initial capital investment in shared instrumentation, but has not provided direct support for ongoing

maintenance and operations costs. Without this support, it has become clear that such instrumentation is used neither at full efficiency nor effectiveness. The plan is to double the Chemical Instrumentation Program over the next five years with most of the increase going to support ongoing maintenance and operations support associated with the new shared shared instruments.

- o Collaborative Research Activities. Multi-investigator research activities aimed at advancing materials chemistry and chemical catalysis, and developing new modern chemical instrumentation will be increased by \$2.5 million. These new multidisciplinary activities offer significant opportunities for fundamental research in the priority areas recommended by the National Academy of Sciences/ National Research Council survey, "Opportunities in Chemistry."
- o Chemical Underpinnings of Biotechnology. The time is ripe for spectacular advances in chemistry at the interface of chemistry and biology. These advances are bound to have applications to human and animal health, and agriculture. This increment of \$5.0 million will be used to continue the planned increase in the Chemistry of Life Processes Initiative that was started in FY 1985, and to balance this multi-investigator support activity with individual project grants in areas such as biomimetic chemistry. The essence of biomimetic chemistry is the synthesis of molecules, or aggregates of molecules in the case of membranes, that mimic some feature of an active biological entity.
- o Computational Science and Engineering. Support for computational chemistry (i.e., mathematical modelling, design of suitable computational methods, the purchase and operation of local computer equipment, and the implementation and documentation of advanced software to solve fundamental chemical problems) will be increased by \$2.26 million. This increase will accelerate research and education in the effective use of modern computers in chemistry, so that tomorrow's chemists are trained to simulate increasingly complete models of chemical, materials, and biological systems.

Each of these increments is an important element in the Foundation's long-term effort to strengthen chemical research in the Nation's colleges and universities.

MATERIALS RESEARCH..... \$ 117,350,000**SUMMARY OF REQUEST**

The request of \$117.35 million is an increase of \$7.7 million or 7.0% over the FY 1986 Current Plan.

PROGRAM ELEMENT	ACTUAL FY 1985	REQUEST FY 1986	CURRENT PLAN FY 1986	ESTIMATE FY 1987	DIFFERENCE FY 1987/86
Solid State Physics.....	\$11,448,350	\$12,400,000	\$11,885,000	\$12,370,000	\$485,000
Solid State Chemistry.....	8,155,950	9,100,000	8,662,000	9,100,000	438,000
Low Temperature Physics.....	7,933,250	8,400,000	8,178,000	8,520,000	342,000
Condensed Matter Theory.....	8,247,950	8,900,000	8,502,000	9,470,000	968,000
Metallurgy.....	9,483,705	10,200,000	9,810,000	10,180,000	370,000
Ceramics and Electronic Materials.....	6,479,498	6,780,000	6,597,000	6,860,000	263,000
Polymers.....	7,561,981	7,600,000	7,121,000	7,460,000	339,000
Instrumentation for Materials Research.....	6,500,900	6,600,000	6,245,000	6,240,000	(5,000)
Materials Research Laboratories.....	27,073,410	30,000,000	27,200,000	27,700,000	500,000
National Facilities.....	11,590,161	12,000,000	10,650,000	10,650,000	0
Materials Research Groups.....	2,500,375	3,700,000	4,800,000	8,800,000	4,000,000
Total, Materials Research.....	\$106,975,530	\$115,680,000	\$109,650,000	\$117,350,000	\$7,700,000

SCIENTIFIC OVERVIEW

The objective of the Materials Research subactivity is to gain a better understanding of the properties of materials in terms of the microscopic interactions among their fundamental constituents and in terms of composition, structure, and processing history. There are two aspects to this objective. First, materials research provides essential scientific knowledge necessary for new technological advances. In many instances, a particular technology is limited by the inability to produce materials with needed properties, such as high strength, corrosion resistance, or special electronic characteristics. Second, materials research is also yielding major conceptual advances in scientific understanding, such as universal principles of phase transitions, new kinds of order in solids, and new materials with unexpected properties.

Many exciting developments in materials research address both of the latter objectives; e.g., research on disordered materials and on surface phenomena. Materials research frequently relates to industrial needs and provides a natural interface between industry and universities. It is a diverse area that is essential to U.S. technology and is at the forefront of fundamental advances in science and engineering. Among the advanced nations, it is one of the most vital areas of competition and one in which international scientific cooperation also plays an important role.

The Materials Research subactivity is administratively organized to provide support through several different funding modes. Materials research is carried on as part of many disciplines -- chemistry, physics, applied mathematics, metallurgy, ceramics, polymer science, and chemical, electrical, and mechanical engineering. Support for individual investigator research, including instrumentation, is provided through the seven scientific research project support (SRPS) programs. Many major problems in materials research require a multi-investigator, multidisciplinary approach. Most multidisciplinary research is supported through the Materials Research Laboratories (MRLs) and, on a lesser scale, through Materials Research Groups (MRGs). Major instrumentation for shared use is provided through the Instrumentation for Materials Research Program and support for unique large scale facilities for research is provided through the National Facilities Program.

The Materials Research Groups Program is in the second year of a planned five-year growth. The Program supports multidisciplinary materials research of a scope intermediate between the individual investigators level of the SRPS programs and the larger team efforts of the Materials Research Laboratory (MRL) Program. In this field, many crucial research problems must be addressed by several disciplines acting in a coordinated effort. The MRG program is designed to provide support for this key research approach.

NSF supports basic research in materials that advances not only the state of knowledge of materials but also our national research capability. Training of researchers is particularly important in view of the demands in industry, universities and government laboratories for materials researchers. This is a field of growing vitality and its continued growth depends critically upon the further development of the community of materials researchers.

NSF provides about 50% of federal support for university basic research in this field. The remainder is largely funded by DOD and DOE.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Solid State Physics....	\$12.40	\$11.89	\$ -0.51	-4.1%
Solid State Chemistry...	9.10	8.66	-0.44	-4.8
Low Temperature Physics.	8.40	8.18	-0.22	-2.6
Condensed Matter Theory.	8.90	8.50	-0.40	-4.4
Metallurgy.....	10.20	9.81	-0.39	-3.8
Ceramics and Electronic				
Materials.....	6.78	6.60	-0.18	-2.7
Polymers.....	7.60	7.12	-0.48	-6.3
Instrumentation for				
Materials Research....	6.60	6.24	-0.36	-5.5
Materials Research Labs.	30.00	27.20	-2.80	-9.3
National Facilities.....	12.00	10.65	-1.35	-11.2
Materials Research Gps..	3.70	4.80	+1.10	+29.7
TOTAL, Subactivity...	\$115.68	\$109.65	\$ -6.03	-5.2%

The difference between the 1986 Request and the Current Plan is a result of the unspecified Congressional reduction. This 5.2 percent reduction results in a general decrease across the scientific research project support (SRPS) programs (4.0 percent), a general decrease in the special programs (5.0 percent) and the following additional specific changes in special programs:

- o After extensive review of the Wisconsin Synchrotron Radiation Center, the support for that center will be reduced by \$0.8 million which, when combined with the general reduction in special programs, results in a decrease in the National Facilities Program of \$1.35 million (11.2 %).
- o Two materials research laboratories are being phased out in order to concentrate limited resources in fewer laboratories to strengthen them. This results in a decrease of \$1.3 million (4.3%) in the MRL program. This, combined with the general decrease in special programs, results in a total decrease of \$2.8 million (9.3 percent) in the MRL Program.
- o Initial indications are that the MRG program will meet an urgent and important need for multidisciplinary research in materials justifying an acceleration in the planned growth. For example, the MRG at Pennsylvania State University studies low temperature processing of ceramics in which chemical reactions rather than a high temperature environment are used in the formation of the materials. Such processes hold promise for less expensive and more readily available ceramic materials.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Solid State Physics.....	\$11.89	\$12.37	\$ 0.48	4.1%
Solid State Chemistry...	8.66	9.10	0.44	5.1
Low Temperature Physics..	8.18	8.52	0.34	4.2
Condensed Matter Theory..	8.50	9.47	0.97	11.4
Metallurgy.....	9.81	10.18	0.37	3.8
Ceramics and Electronic Materials.....	6.60	6.86	0.26	4.0
Polymers.....	7.12	7.46	0.34	4.7
Instrumentation for Materials Research....	6.24	6.24	0.00	0.0
Materials Research Labs..	27.20	27.70	0.50	1.8
National Facilities.....	10.65	10.65	0.00	0.0
Materials Research Gps..	4.80	8.80	4.00	83.3
TOTAL, Subactivity....	\$109.65	\$117.35	\$ 7.70	7.0%

The requested increase is to meet the following needs:

- o The Materials Research Groups (MRG) Program, promises to play a key role in advancing the field. The Program is still in the early stages but indications are that the most appropriate level of support is considerably higher than that currently available. The requested increase of \$4.0 million is a significant step toward the level needed and will support 5-7 new MRG efforts.
- o The backbone of materials research remains individual investigator efforts. Within all programs of the Subactivity, particularly the SRPS programs, a new effort to enhance academic capability and hence industrial strength, in materials processing will provide \$3.0 million. This effort, to be carried out jointly with the relevant engineering disciplines, will provide a focused enhancement of basic research relating to materials synthesis and processing. This results in a general increase of 1.56% proposed for SRPS efforts, exclusive of the thrust in computational science and engineering.
- o The thrust in Computational Science and Engineering is designed to meet a pressing need in materials research for supporting advanced computational efforts. Since this is largely in the Condensed Matter Theory Program, \$0.88 million of this emphasis is allocated to that program. In addition, \$1.37 million is to be provided to the other SRPS programs for this emphasis and \$0.5 million to the MRL program.

ENGINEERING \$ 185,470,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Engineering is \$185.5 million, an increase of \$23.0 million or 14.2 percent over the FY 1986 Current Plan of \$162.5 million. The changes in individual subactivities are as follows:

<i>Subactivity</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
I. Chemical, Biochemical, and Thermal Engineering.....	\$29,177,620	\$29,360,000	\$29,180,000	\$30,210,000	\$1,030,000
II. Mechanics, Structures, and Materials Engineering.....	23,309,733	23,650,000	23,700,000	26,270,000	2,570,000
III. Electrical, Communications and Systems Engineering.....	25,805,286	26,680,000	25,700,000	26,270,000	570,000
IV. Design, Manufacturing and Computer Engineering.....	17,464,303	20,390,000	18,700,000	21,670,000	2,970,000
V. Emerging and Critical Engineering Systems.....	34,960,907	38,500,000	36,195,000	43,050,000	6,855,000
VI. Cross-Disciplinary Research.....	19,910,268	31,490,000	29,000,000	38,000,000	9,000,000
Total.....	\$150,620,125	\$170,070,000	\$162,475,000	\$185,470,000	\$22,995,000

NSF ROLE

The Foundation's Engineering (ENG) Activity seeks to promote the progress of engineering and technology to ensure national prosperity and security through the support of research and related activities in all engineering fields.

The overall goals of ENG are to ensure that the U.S. stays at the frontier of engineering research; that U.S. schools produce the world's best engineers; that the Nation benefits from its full engineering research potential; and that sufficient engineering knowledge and personnel are available to stimulate innovation and technological advances. Accomplishment of these goals will help the U.S. maintain its technological leadership and improve its industrial competitiveness over the long term.

Although ENG's research budget is small compared to the total U.S. engineering enterprise, it has a unique and broad mandate: to move engineering research and education forward in all fields. Consequently, ENG emphasizes high-leverage, fundamental and cross-disciplinary research that has great potential to catalyze and expand the engineering knowledge base and create an environment in which technological innovation can occur. This catalytic role also involves stimulating and coordinating support for engineering research from other Federal agencies, State and local governments, and from the private sector.

The programs within the ENG activity are designed to:

- o **Maintain strength in established "science-driven" fields of engineering.** Research is supported to advance knowledge of engineering principles, methodologies, and systems that provide the foundation for technological advances. Three subactivities focus on this objective: Engineering Science in Chemical, Biochemical, and Thermal Engineering (CBTE), which expands the engineering knowledge base used for the recovery of raw materials and energy resources; Engineering Science in Mechanics, Structures, and Materials Engineering (MSME) which advances engineering knowledge in the behavior of solids and fluids under static and dynamic loading; and Engineering Science in Electrical, Communications, and Systems Engineering (ECSE) which supports research on the analysis, design, and fabrication of devices and systems that generally involve critical electrical and electronic technologies.
- o **Create engineering science strength in "technology-driven" areas that lack strong science bases and have not been the focus of significant academic research.** This is chiefly pursued by Science Base Development in Design, Manufacturing, and Computer Engineering (DMCE) which supports research in such fields as computer engineering, design, synthesis, manufacturing, robotics, automation and systems integration, all areas vital to maintaining our competitive edge.
- o **Build strong engineering knowledge bases and academic infrastructure for emerging technology areas and act as a catalyst for advances in critical engineering systems.** This objective is achieved through Fundamental Research for Emerging and Critical Engineering Systems (ECES). Major emerging research topics include: biotechnology, bioengineering, lightwave technology, and computational engineering. Critical engineering systems areas include earthquake and other hazards mitigation, environmental engineering, and systems engineering for large structures. Research in these areas cuts across traditional engineering disciplines and requires different approaches and/or institutional mechanisms to achieve progress.
- o **Stimulate cross-disciplinary research and strengthen links between engineering schools, industrial firms, and government laboratories.** This objective is pursued by all ENG subactivities but receives particular focus in the Cross-Disciplinary Research (CDR) subactivity which supports the Engineering Research Centers and the Industry/University Cooperative Research Centers. CDR focuses research teams on areas where the infusion of knowledge from several disciplines and viewpoints will enhance the probability of innovative and industrially relevant research.

ENG serves as balance wheel for the support of fundamental engineering research. NSF is the only Federal agency with direct responsibility to move engineering forward in all fields and to find ways to improve the engineering research and education environment generally. Moreover, NSF has the unique Federal role to stimulate industry/university interaction in areas not associated with its near term needs or particular mission.

The following table indicates support for basic research to universities by agency and engineering field in FY 1984:

**FEDERAL SUPPORT FOR THE CONDUCT OF BASIC
RESEARCH TO UNIVERSITIES AND COLLEGES
FISCAL YEAR 1984**

AGENCY	NSF	DOD	DOE	NASA	OTHER AGENCIES	TOTAL
AERONAUTICAL/ASTRONAUTICAL	*	53%	--	47%	*	100%
CHEMICAL ENGINEERING	74%	4%	21%	1%	*	100%
CIVIL ENGINEERING	93%	7%	--	--	*	100%
ELECTRICAL ENGINEERING	37%	59%	*	4%	*	100%
MECHANICAL ENGINEERING	35%	50%	9%	6%	*	100%
METALLURGICAL/MATERIALS	28%	46%	18%	8%	*	100%
OTHER FIELDS	24%	*	6%	8%	62%	100%
TOTAL ENGINEERING	37%	39%	8%	9%	7%	100%

*LESS THAN 1%

CHANGES IN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Chemical, Biochemical, & Thermal Engineering..	\$ 29.36	\$ 29.18	\$-0.18	-0.6%
Mechanics, Structures, & Materials Engineering	23.65	23.70	0.05	0.2
Electrical, Communica- tions & Systems Engrg..	26.68	25.70	-0.98	-3.7
Design, Manufacturing, & Computer Engineering.	20.39	18.70	-1.69	-8.3
Emerging and Critical Engineering Systems....	38.50	36.20	-2.30	-6.0
Cross-Disciplinary Research	31.49	29.00	-2.49	-7.9
TOTAL, Activity.....	\$170.07	\$162.48	\$-7.59	-4.5%

The FY 1986 Current Plan is \$162,475,000, which is a decrease of \$7,595,000 or 4.5 percent from the FY 1986 Budget Request of \$170,070,000. The decrease results from Congressional action, Foundation-wide reductions, and program readjustments and realignments in response to changing research opportunities and priorities. In particular, reductions have been made in those areas which had the most substantial growth in the FY 1986 Budget Request, such as: computer integrated research, instrumentation, sensing and measurement, biotechnology, and the Engineering Research Centers. Funding for these activities is still substantially increased over FY 1985 in recognition of their high priority.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Chemical, Biochemical, & Thermal Engineering..	\$ 29.18	\$ 30.21	\$ 1.03	3.5%
Mechanics, Structures, & Materials Engineering	23.70	26.27	2.57	10.8
Electrical, Communica- tions & Systems Engrg..	25.70	26.27	0.57	2.2
Design, Manufacturing, & Computer Engineering.	18.70	21.67	2.97	15.9
Emerging and Critical Engineering Systems....	36.20	43.05	6.86	18.9
Cross-Disciplinary Research.....	29.00	38.00	9.00	31.0
TOTAL, Activity.....	\$162.48	\$185.47	\$22.99	14.2%

In FY 1987, the ENG activity is increased by \$22,995,000 or 14.2 percent over the FY 1986 Current Plan, to a total of \$185,470,000. In addition, reductions in lower priority efforts have been made across various programs to allow expansion of areas of opportunity. The FY 1987 Request will enable NSF to address the needs of Engineering by providing:

- o An increase of \$4.2 million or 5.3 percent, from \$78.6 to \$82.8 million, for research in science-driven technological fields (i.e. in the CBTE, MSME and ECSE subactivities). Support for materials processing would be increased by about \$3 million. Such research will focus on the fabrication of final products directly from molten metals, oxide powders, monomers, and pre-polymers bypassing traditional intermediate processes.
- o An increase of \$3.0 million or 15.9 percent, for the DMCE subactivity, from \$18.7 to \$21.7 million, for research in design and synthesis, computer engineering, manufacturing systems and automation to establish strong engineering science bases in these areas. Research on advanced computers will be increased by about \$2.0 million, focusing on the design, realization, and prototyping of novel high performance special purpose computers.
- o An increase of \$6.9 million or 18.9 percent, for Emerging and Critical Engineering Systems (ECES), from \$36.2 to \$43.1 million to permit:

(1) Establishment of a new program in Computational Engineering at \$3 million. Attention will be focused on developing, adopting, and optimizing new algorithms and techniques for more effective computational tools ranging from microprocessors to supercomputers.

(2) Substantial growth for the Biotechnology program, which increases from \$3.0 to \$5.0 million, to support cross-disciplinary research groups to address key technical issues and establish the knowledge base needed for future research and innovation.

(3) Increased support for the Earthquake Hazard Mitigation program and for research concerned with environmental hazards and public safety issues.

- o An increase of \$9.0 million or 31 percent, for the Cross-Disciplinary Research subactivity, from \$29.0 to \$38.0 million will provide for:

(1) \$12.0 million or 52 percent increase for Engineering Research Centers. The FY 1986 Current Plan of \$23.0 million will permit about five new ERCs, bringing the total to eleven. The increase in FY 1987 will provide for the establishment of about four new ERCs. This continues NSF's effort to support research in areas that can lead to improvements in U.S. industrial competitiveness.

(2) \$3.0 million reduction in the Industry/University Cooperative Research Projects program. This matching-funds program has achieved its objective of stimulating cooperative research and will be mainstreamed with the ongoing research activities of the Foundation.

The FY 1987 Budget Request also provides funding for several activities that cut across subactivity lines. These include:

- o \$6.0 million increase in the Presidential Young Investigators (PYI) program, from \$12.5 to \$18.5 million, to permit the support of 100 new faculty members, bringing the total of engineering PYIs to be supported in FY 1987 to 350.
- o \$3.0 million augmentation for undergraduate research participation and faculty improvement. This includes the University/Industry/ Government Partnership for Quality Engineering Personnel program; increased support for undergraduate research assistants, including those at predominantly undergraduate institutions; and activities to facilitate the full participation of women, minorities, and handicapped scientists and engineers.
- o Within ENG research programs, emphasis will be placed on supporting the especially creative and original research ideas of engineering students, particularly at engineering schools that currently do not receive substantial support from NSF. The objective is to enhance the undergraduate's perception of the value of a graduate education and research career.

CHANGES IN BUDGET STRUCTURE

The Solid Mechanics program in the MSME subactivity has been renamed "Solid and Geomechanics" to more adequately reflect the research communities it supports.

A new program in "Computational Engineering" is established in the ECES subactivity.

The Industry/University Cooperative Research Projects program in the CDR subactivity is terminated in FY 1987.

ENGINEERING SCIENCE IN CHEMICAL, BIOCHEMICAL, AND THERMAL ENGINEERING \$ 30,210,000

SUMMARY OF REQUEST

Support for the Chemical, Biochemical and Thermal Engineering subactivity is increased by \$1.0 million or 3.5 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Kinetics and Catalysis Engineering.....	\$2,974,041	\$3,450,000	\$3,100,000	\$3,340,000	\$ 240,000
Biochemical and Biomass Engineering.....	3,072,429	2,880,000	3,030,000	2,580,000	(470,000)
Process and Reaction Engineering.....	3,529,415	3,230,000	3,450,000	3,710,000	260,000
Multiphase and Interfacial Phenomena....	3,318,000	3,600,000	3,400,000	3,560,000	160,000
Separation and Purification Processes...	2,930,613	3,500,000	3,100,000	3,240,000	140,000
Thermodynamics and Transport Phenomena..	4,556,106	4,440,000	4,600,000	4,750,000	150,000
Thermal Systems and Engineering.....	8,797,024	8,260,000	8,500,000	9,050,000	550,000
Total.....	\$29,177,628	\$29,360,000	\$29,180,000	\$30,210,000	\$1,030,000

SCIENTIFIC OVERVIEW

The Chemical, Biochemical, and Thermal Engineering (CBTE) subactivity seeks to expand the engineering knowledge base needed in a large number of industrial processes involving the recovery, transformation, and utilization of raw materials and energy resources. Research deals with the formulation and rational design of catalysts and enzyme systems; interfacial and transport phenomena; characterization and processing of particulate systems; and the development of effective, energy-efficient and economic unit operations, and separation systems for materials processing and purification.

Two of the most promising areas for new industrial ventures which, properly nourished, will provide industrial stimulation, growth of income, and increased exports, are bioprocessing technology and processing methods for manufacturing electronic materials and components. These are extremely important to U.S. industries in their efforts to compete internationally. All programs in CBTE support research in these interdisciplinary areas, many with cooperation between universities and industry groups.

Most of the new products, processes, and techniques now identified as high technology had their beginnings in basic research within the past decade. A large fraction of these results began in university laboratories as experiments in basic science. Therefore, a majority of industrial firms depend upon the academic community to develop fundamental knowledge and to supply trained people who can formulate and transform novel concepts into new processes and products. NSF's major role is to help the university system provide a healthy research environment for such discoveries and train future generations of scientists and engineers. NSF provides funds at an early stage when most private sector firms cannot justify expenditures because results are too uncertain to predict.

The CBTE subactivity provides 74 percent of the Federal basic research support to the university chemical engineering community. The other significant funding agency is the Department of Energy.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Kinetics and Catalysis	\$ 3.45	\$ 3.10	\$-0.35	-10.1%
Biochemical and Biomass Engineering.....	2.88	3.03	0.15	5.2
Process & Reaction Engrg	3.23	3.45	0.22	6.8
Multiphase & Interfacial Phenomena.....	3.60	3.40	-0.20	-5.6
Separation & Purifica- tion Processes.....	3.50	3.10	-0.40	-11.4
Thermodynamics & Trans- port Phenomena.....	4.44	4.60	0.16	3.6
Thermal Systems and Engineering.....	8.26	8.50	0.24	2.9
TOTAL, Subactivity....	\$29.36	\$29.18	\$-0.18	-0.6%

The FY 1986 Current Plan is \$180,000 less than the FY 1986 Budget Request of \$29,360,000. This represents the subactivity's share of an unspecified Congressional budget reduction. Readjustments were made in several programs to respond to changing research opportunities and priorities. The growth of two programs, Kinetics and Catalysis, and Separation and Purification Processes originally scheduled for large increases, had to be reduced proportionately more to permit modest increases in other program elements.

FY 1987 BUDGET HIGHLIGHTS*(Millions of Dollars)*

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Kinetics and Catalysis	\$ 3.10	\$ 3.34	\$ 0.24	7.7%
Biochemical and Biomass Engineering.....	3.03	2.56	-0.47	-15.4
Process & Reaction Engrg	3.45	3.71	0.26	7.7
Multiphase & Interfacial Phenomena.....	3.40	3.56	0.16	4.7
Separation & Purifica- tion Processes.....	3.10	3.24	0.14	4.5
Thermodynamics & Trans- port Phenomena.....	4.60	4.75	0.15	3.3
Thermal Systems and Engineering.....	8.50	9.05	0.55	6.5
TOTAL, Subactivity....	\$29.18	\$30.21	\$ 1.03	3.5%

CBTE is increased by \$1.03 million or 3.5 percent over the FY 1986 Current Plan of \$29.18 million. The decrease in the Biochemical and Biomass Engineering Program was made to minimize the overlaps between it and the Biotechnology Program in the ECES subactivity. Specifically, the request will provide:

- o An increase of \$0.2 million for Kinetics and Catalysis to support research and equipment for projects applying sophisticated techniques such as magnetic resonance and electron energy loss spectroscopy to key problems in catalysis. Such research examines surface sites and their interaction with reactant molecules directly for more definitive delineation of catalytic mechanisms.
- o Process and Reaction Engineering is increased by \$0.3 million to permit more emphasis on the development of expert systems for the synthesis, automation and control of large scale complex chemical processes and the study of novel reactor configurations for the manufacture of components needed by the microelectronics industry. The high precision and purity needed in such processes demand unusual and efficient reactor environments that are free of contamination.
- o Thermal Systems and Engineering is increased by \$0.6 million or 6.5 percent for heat transfer research in metals processing (e.g. grinding); in biological systems and medical processes (e.g. in human tissue); in microelectronics; and in the design of heat transfer systems using irreversible thermodynamic criteria. Emphasis is also placed on plasma chemistry and arc technology as well as the study of the fundamental phenomena in combustion technology.

ENGINEERING SCIENCE IN MECHANICS, STRUCTURES, AND MATERIALS ENGINEERING\$ 26,270,000

SUMMARY OF REQUEST

Support for research in the Mechanics, Structures, and Materials Engineering subactivity is increased by \$2.6 million, or 10.8 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Solid and Geomechanics.....	\$6,012,742	\$5,660,000	\$6,100,000	\$6,470,000	\$370,000
Structures and Building Systems.....	4,259,563	4,400,000	3,900,000	3,610,000	(290,000)
Fluid Dynamics and Hydraulics.....	5,306,073	5,400,000	5,600,000	6,130,000	\$530,000
Tribology.....	1,890,700	2,040,000	2,000,000	2,150,000	150,000
Dynamic Systems and Control.....	2,782,527	2,850,000	2,800,000	2,910,000	110,000
Materials Engineering and Processing..	3,058,128	3,300,000	3,300,000	5,000,000	1,700,000
Total.....	\$23,308,733	\$23,650,000	\$23,700,000	\$26,270,000	\$2,570,000

SCIENTIFIC OVERVIEW

Mechanics, Structures, and Materials Engineering (MSME) expands the engineering science base in the behavior of solids and fluids under static and dynamic loading. It considers metals, polymers, composites, and geomaterials in many service conditions including temperature extremes. It deals with the motion of fluids in engineering systems and the performance of high speed precision machines, as well as the friction, lubrication and wear which limit service life.

MSME also supports research on the control of dynamic systems and the processing of engineering materials ranging from the improvement and the development of materials for extreme environments to the development of more efficient, novel processing methods that will reduce the costs of production.

This research results in higher performance engineering systems that include more efficient, reliable, economical and stronger buildings, safer and more long-lived coastal and ocean structures, aircraft that operate with less drag, and more reliable, high speed machines. The research significantly contributes to automation, for wider use in manufacturing, construction processes, and offices. Extensive efforts are devoted to computer simulation, while maintaining a balance with experimental and analytical methods to advance these technologies effectively.

Program balance and areas of emphasis are developed with careful consideration of the activities of the mission-oriented Federal agencies that provide funding in related fields. For example, in Solid and Geomechanics there is close liaison with related programs in the Department of Defense such as the Air Force Office of Scientific Research and the Office of Naval Research.

Research in all elements of MSME is influenced by advances in computing. Computer simulation of formerly intractable problems has opened new areas for research. Of particular importance is the area of tribology, the science of friction, lubrication and wear. It is estimated that 75 percent of the \$20 billion wasted annually by the friction and wear of moving parts could be saved through improved design resulting from a better understanding of the fundamental processes involved. Another thrust is in the processing of engineering materials to effect greater savings and create new products through novel processing systems.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Solid and Geomechanics..	\$ 5.66	\$ 6.10	\$ 0.44	7.8%
Structures and Building Systems.....	4.40	3.90	-0.50	-11.4
Fluid Dynamics and Hydraulics.....	5.40	5.60	0.20	3.7
Tribology.....	2.04	2.00	-0.04	-2.0
Dynamic Systems and Control.....	2.85	2.80	-0.05	-1.8
Materials Engineering and Processing.....	3.30	3.30	0.00	0.0
TOTAL, Subactivity....	\$23.65	\$23.70	\$ 0.05	0.2%

The difference between the 1986 Budget Request of \$23.65 million and the FY 1986 Current Plan of \$23.70 million is the result of increases in Solid and Geomechanics, and Fluid Dynamics and Hydraulics, to take advantage of the availability of advanced computational facilities to solve important problems. The decrease in Structures and Building Systems reflects a reduced emphasis on research in the analysis of building systems.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Solid and Geomechanics..	\$ 6.10	\$ 6.47	\$.37	6.1%
Structures and Building Systems.....	3.90	3.61	- 0.29	-7.4
Fluid Dynamics and Hydraulics.....	5.60	6.13	0.53	9.5
Tribology.....	2.00	2.15	0.15	7.5
Dynamic Systems and Control.....	2.80	2.91	0.11	3.9
Materials Engineering and Processing.....	3.30	5.00	1.70	51.5
TOTAL, Subactivity....	\$23.70	\$26.27	\$ 2.57	10.84%

The MSME increase of \$2.57 million or 10.8 percent, provides:

- o Increased research support on new processing methods that extend the performance of engineering materials into severe environmental regimes e.g. greater temperature extremes. Such methods will significantly reduce the costs of production, manufacturing, or in-service use by optimizing the relationships between processing, properties, and microstructure. This research will ultimately result in development of new materials
- o Increased research on fluid flows with deformable or moving boundaries occur in processes with solidification for both metals and polymers. Other areas include systems in which fluid pressure and shear stresses exceed the values for which a rigid boundary can be assumed. Also to be emphasized are scour and redeposition in sediment-laden flows. The complexities associated with flows with prior unknown boundaries require increased emphasis on numerical simulations and development of efficient computational algorithms.
- o The \$0.29 million decrease in the Structures and Building Systems area reflects reduced emphasis in research on the analysis of building systems. Also, automation in construction will be jointly supported with the Automation and Systems Integration program in the DMCE subactivity.

CHANGES IN BUDGET STRUCTURE

The name of the Solid Mechanics Program has been changed to Solid and Geomechanics to reflect the inclusion of geotechnical engineering research.

**ENGINEERING SCIENCE IN ELECTRICAL, COMMUNICATIONS,
AND SYSTEMS ENGINEERING \$ 26,270,000**

SUMMARY OF REQUEST

Support for research in the Electrical, Communications, and Systems Engineering subactivity is increased by \$0.6 million or 2.2 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Solid State and Microstructures	\$7,701,563	\$7,700,000	\$7,200,000	\$7,250,000	\$ 50,000
Communications Systems and Signal Processing.....	5,143,752	5,200,000	5,300,000	5,500,000	200,000
Systems Theory and Operations Research...	5,057,593	5,200,000	5,200,000	5,400,000	200,000
Quantum Electronics, Waves and Beams.....	4,932,924	4,600,000	4,900,000	4,980,000	80,000
Instrumentation, Sensing and Measurement	2,969,454	3,980,000	3,100,000	3,140,000	40,000
Total	\$28,805,286	\$26,680,000	\$25,700,000	\$26,270,000	\$570,000

SCIENTIFIC OVERVIEW

Electrical, Communications, and Systems Engineering (ECSE) supports research on the analysis, design, and fabrication of devices and systems.

This subactivity seeks to help the Nation retain and extend its competence and leadership in the information and energy fields -- both vital to all forms of industrial enterprise. Achievement of this goal will require research progress in such areas as control systems design, and information processing and transmission. This in turn requires the ability to produce efficiently and economically high-density electronic devices with high reliability. These devices allow production of the systems needed for advanced communications, automated design, and industrial process monitoring and control.

Other research funded by ECSE includes development of adaptive and flexible control systems applicable to large structures, buildings, power networks, and automated industrial processes. The subactivity also supports research to enhance real-time industrial process monitoring and control, to improve remote sensing capabilities, and to develop nondestructive evaluation technologies.

Much ECSE-funded research usefully complements the activities of DARPA, NASA, and other Federal agencies, as well as research supported by other NSF subactivities. For example, research in the electrical engineering area for the last five years has led to substantial increases in the number of electronic circuits that can be packaged in a given device size.

A recent example of microminiaturization was demonstrated at the NSF-sponsored Submicron Facility at Cornell University where scientists in collaboration with researchers from AT&T Bell Laboratories created a gallium arsenide (GaAs) switch that operated faster than any previously devised semi-conductor device. This speed was achieved through use of configurations only one-third of a micron, which is one thousandth of a millimeter. The new technology will be used in communications equipment, microprocessors, and computer memories.

This increased density has influenced research in mechanics, chemistry, biology, and other disciplines, and has prompted ECSE to look toward cross-disciplinary opportunities in such areas as electromechanical and electrochemical research. Special seminars will explore opportunities for academic researchers to participate more effectively in multidisciplinary teams.

CHANGES BETWEEN FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Solid State & Micro- Structures.....	\$ 7.70	\$ 7.20	\$-0.50	-6.5%
Communications Systems and Signal Processing..	5.20	5.30	0.10	1.9
Systems Theory and Operations Research....	5.20	5.20	0.00	0.0
Quantum Electronics, Waves, and Beams.....	4.60	4.90	0.30	6.5
Instrumentation, Sensing, and Measurement.....	3.98	3.10	-0.88	-22.1
TOTAL, Subactivity....	\$26.68	\$25.70	\$-0.98	-3.7%

The difference between the FY 1986 Request of \$26.68 million and the Current Plan of \$25.70 million, \$0.98 million, resulted from the unspecified Congressional reduction from NSF's FY 1986 Request. The reduction in the Solid State and Microstructures Engineering (SSME) program reflects the transfer of some activities to other elements within ENG. The substantial growth planned for the Instrumentation, Sensing and Measurement (ISM) program has been cut back, but even with the reduction, the planned amount remains above the FY 1985 actual level.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Solid State & Micro- Structures.....	\$ 7.20	\$ 7.25	\$ 0.05	0.7%
Communications Systems and Signal Processing..	5.30	5.50	0.20	3.8
Systems Theory and Operations Research....	5.20	5.40	0.20	3.9
Quantum Electronics, Waves, and Beams.....	4.90	4.98	0.08	1.6
Instrumentation, Sensing and Measurement.....	3.10	3.14	0.04	1.3
TOTAL, Subactivity....	\$25.70	\$26.27	\$ 0.57	2.2%

The requested increase of \$0.57 million, or about two percent, represents an approximately constant real level of effort. Within this level of effort, adjustments are made to assure that the highest priority topics are increased. Examples of such topics include:

- o Advanced digital communication systems which integrate voice, video, and data transmissions over a single path and thus increase the capacity of that transmission;
- o Small, environmentally resistant intelligent sensors to enhance machine perception and decisionmaking in robotics, bioengineering, and process control;
- o Modelling of complex industrial systems by mathematical equations to allow development of more efficient control mechanisms; and
- o Improved characterization of semiconductor device performance to produce smaller and more effective devices.

SCIENCE BASE DEVELOPMENT IN DESIGN, MANUFACTURING, AND COMPUTER ENGINEERING\$21,670,000

SUMMARY OF REQUEST

Support for research in the Design, Manufacturing and Computer Engineering subactivity is increased by \$3.0 million or 15.9 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Computer Engineering.....	\$5,310,227	\$5,460,000	\$5,700,000	\$7,500,000	\$1,800,000
Design Theory and Methodology.....	1,623,390	3,000,000	2,800,000	3,200,000	400,000
Computer Integrated Engineering.....	1,610,203	3,000,000	2,000,000	2,250,000	250,000
Manufacturing Systems.....	5,064,732	4,970,000	5,100,000	5,270,000	170,000
Automation and Systems Integration....	3,855,751	3,960,000	3,100,000	3,450,000	350,000
Total.....	\$17,464,303	\$20,390,000	\$18,700,000	\$21,670,000	\$2,970,000

SCIENTIFIC OVERVIEW

The Design, Manufacturing, and Computer Engineering subactivity seeks to establish strong science bases for the new engineering sciences of design, manufacturing, and computer engineering. These science bases are formed by developing bodies of knowledge and principles. The subactivity supports research on new hardware-software systems, machines, and technologies in such areas as: computer architecture and systems; very large scale integrated (VLSI) circuit design; robotics; programmable automation; and computer integrated manufacturing systems.

Research in these fields, in contrast to the traditional engineering sciences, tends to be technology-driven and relates more to the state of technology than to the state of any underlying science. In spite of impressive growth, these areas generally lack a broad base of scientific knowledge. Therefore, a major goal of this subactivity is to build research communities with commonly accepted research paradigms.

Dramatic advances in semiconductor and communications technology have led to an explosion in computer technology and have brought about a rebirth of computer engineering research in U.S. universities. Universities now have the capability to design and build novel, high-performance, special purpose computing systems. This is due to the development of sophisticated design tools needed to deal with hundreds of thousands of transistors on a chip, i.e., Very Large Scale Integration (VLSI), and wide university access to the facility that provides semi-conductor fabrication services, i.e., MOSIS. Universities are once again in the forefront of research on new computer systems. The revolution in microelectronics, communications, and high-performance computing is now spreading to design and manufacturing.

Design is involved in all areas of engineering and plays a key role in determining how American manufacturing fares against foreign competition. Yet, design is a relatively neglected and poorly understood area. NSF support plays an important role in encouraging basic research on new design methodologies and principles of design. Recently, advances in design methodologies have occurred in a number of engineering areas, such as VLSI design, chemical process design and software design. This progress is due to the advances in available computational power, due to constraining and limiting the design space, and to a convergence of ideas and methodologies that have given structure to previously ill-defined problems.

The emphasis in DMCE is on two streams of research, one seeking a deeper understanding for manufacturing the other on designing new computers. The interaction and synthesis of these two streams and of research promise to give U.S. manufacturing industries a much better capability to increase their productivity and competitiveness. Universities are an important source not only of both forms of research, but also of their synthesis.

A number of recent NAS studies have dealt with computer architecture, the role of computers in design and manufacturing, and robotics. These studies have helped shape the FY 1986 and FY 1987 research emphases.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Computer Engineering...	\$ 5.46	\$ 5.70	\$ 0.24	4.4%
Design Theory & Method- ology.....	3.00	2.80	-0.20	-6.7
Computer Integrated Engineering.....	3.00	2.00	-1.00	-33.3
Manufacturing Systems...	4.97	5.10	0.13	2.6
Automation and Systems Integration.....	3.96	3.10	-0.86	-21.7
TOTAL, Subactivity...	\$20.39	\$18.70	\$-1.69	-8.3%

The difference between the FY 1986 Request of \$20.39 million and the Current Plan of \$18.70 million, is the result of an unspecified Congressional budget cut. Since major growth occurred in FY 1985 in computer integrated engineering (increased by 220 percent) and automation (increased by 160 percent), these areas were cut in FY 1986 to provide for more orderly program growth. The decrease in automation also reflects a shift in funding responsibilities to other areas, including computer engineering and manufacturing systems.

ENG - IV -2

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Computer Engineering....	\$ 5.70	\$ 7.50	\$ 1.80	31.6%
Design Theory & Method- ology.....	2.80	3.20	0.40	14.3
Computer Integrated Engineering.....	2.00	2.25	0.25	12.5
Manufacturing Systems...	5.10	5.27	0.17	3.3
Automation and Systems Integration.....	3.10	3.45	0.35	11.3
TOTAL, Subactivity....	\$18.70	\$21.67	\$ 2.97	15.9%

The FY 1987 Budget Request of \$21.67 million is \$2.97 million or 15.9 percent above the FY 1986 Current Plan. This increase provides significant growth in computer engineering, particularly for research on advanced computers. The FY 1985 and FY 1986 budgets have provided significant growth in the design, automation, and computer integrated engineering areas in order to build them up rapidly from a small base. This has been accomplished and more modest growth is planned for these areas in FY 1987.

Computer Engineering research in universities is undergoing explosive growth and is on the threshold of exciting research breakthroughs. The 1985 National Academy of Engineering study report on "New Directions for Engineering in the National Science Foundation" recognized this. The report recommended that in the national interest, substantially larger resources will have to be allocated to support research on computer systems and their uses in engineering design, robotics, and manufacturing.

The National Academy of Sciences Committee on Science, Engineering and Public Policy (COSEPUP) reports on "Computer Architecture" (1984) and "The Role of Computers in Design and Manufacturing" (1983), and the 1985 FCCSET Panel Report on High Performance Computing deal with the research opportunities and needs in these areas. They make strong technical cases for research emphases in such areas as parallel processing, special purpose high-performance computer architectures, and networking.

The FY 1987 subactivity budget reflects these research priorities while continuing the research emphases in design that were initiated in FY 1986. Increased emphasis will be given to:

- o Research on advanced computers. This will permit the design, realization and prototyping of novel high-performance special purpose computers designed to open up new engineering research areas, e.g., robotics, solid modeling,

computer graphics, computer vision, as well as provide for advances in computer architecture. Exploratory studies of new high-performance computer architectures that perform both numerical and symbolic processing will also be encouraged.

- o The continuation and expansion of the joint NSF/DARPA program that allows qualifying U.S. universities to use the DARPA fast-turnaround VLSI implementation service, MOSIS, as part of university-based research and educational programs. NSF-supported researchers will now have access to advanced fabrication technologies and fast prototyping facilities for building computer systems.
- o Improved hardware and software tools for VLSI circuit design and software systems aimed at integrating and automating different levels of computer-based systems that support design and manufacturing.

FUNDAMENTAL RESEARCH FOR EMERGING AND CRITICAL ENGINEERING SYSTEMS \$ 43,050,000

SUMMARY OF REQUEST

Support for research in the Emerging and Critical Engineering Systems subactivity is increased by \$6.9 million or 18.9 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Biotechnology.....	\$1,529,217	\$4,300,000	\$3,000,000	\$5,000,000	\$2,000,000
Bioengineering and Research for the Handicapped.....	4,645,317	4,680,000	4,700,000	5,060,000	360,000
Computational Engineering.....	0	0	0	3,000,000	3,000,000
Lightwave Technology.....	2,035,881	3,000,000	3,000,000	3,230,000	230,000
Earthquake Hazard Mitigation.....	17,083,982	16,400,000	15,700,000	16,500,000	800,000
Environmental Engineering.....	4,374,814	5,480,000	4,365,000	4,420,000	55,000
Systems Engineering for Large Structures..	2,896,104	2,580,000	2,900,000	3,120,000	220,000
Natural and Man-Made Hazard Mitigation..	2,395,592	2,060,000	2,530,000	2,720,000	190,000
Total.....	\$34,960,907	\$38,500,000	\$36,185,000	\$43,050,000	\$6,855,000

SCIENTIFIC OVERVIEW

Emerging engineering systems are those that show great promise for enhancing the national economy, employment base and security, and for which the Nation's universities do not yet have an adequate research and human resources base. Major research topics include biotechnology, lightwave technology, bioengineering and research to aid the handicapped, and computational engineering.

Critical engineering systems are those that are essential, either because they significantly affect the economic viability and security needs of the Nation, or because they are required in maintaining the public infrastructure. Major research topics include earthquake hazard mitigation, natural and man-made hazard mitigation, environmental engineering, and systems engineering for large structures.

Universities are mostly structured along disciplinary lines and find it difficult to build an effective research capability in emerging and critical engineering systems. NSF plays a catalytic role by stimulating university-based research in these areas.

Cross-disciplinary research between engineering and the life sciences presents both a concern and a challenge. It holds the promise of synergism because neither engineering nor the life sciences communities doing research alone can provide the benefits that will result from doing it together. This is particularly true of biotechnology, and bioengineering and research to aid the handicapped. One planned NSF response to this challenge is to provide grants to small cross-disciplinary groups of engineering and life science researchers who have common, well-defined research targets.

NSF is one of the four Federal agencies that, under the Earthquake Hazards Reduction Act of 1977, have a multi-agency approach to mitigating earthquake hazards. NSF's activities are characterized by special emphasis on university-based research.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Biotechnology.....	\$ 4.30	\$ 3.00	\$-1.30	-30.2%
Bioengineering & Research for the Handicapped....	4.68	4.70	0.02	0.4
Lightwave Technology....	3.00	3.00	0.00	0.0
Earthquake Hazard Mitigation.....	16.40	15.70	-0.70	-4.3
Environmental Engineering Systems Engineering for Large Structures.....	5.48	4.37	-1.11	-20.3
Natural and Man-Made... Hazard Mitigation....	2.58	2.90	0.32	12.4
	2.06	2.53	0.47	22.8
TOTAL, Subactivity.....	\$38.50	\$36.20	-\$ 2.30	- 6.0%

The FY 1986 Current Plan represents a decrease of \$2.3 million, or 6.0 percent over the FY 1986 Request. As a result of unspecified Congressional budget reductions and identified funding opportunities, Biotechnology's growth was slowed somewhat in FY 1986. The program is still double the FY 1985 actual amount of \$1.5 million.

There is a modest shift in funds from Earthquake Hazard Mitigation to other Natural and Man-Made Hazards and to Systems Engineering for Large Structures, where the research opportunities are great and are complementary to earthquake research objectives. The reduction in Environmental Engineering reflects decreased research in air pollution transport, where a number of the research objectives have been attained.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Biotechnology.....	\$ 3.00	\$ 5.00	\$ 2.00	66.7%
Bioengineering & Research for the Handicapped....	4.70	5.06	0.36	7.7
Computational Engineering	0.00	3.00	3.00	-
Lightwave Technology....	3.00	3.23	0.23	7.7
Earthquake Hazard Mitigation.....	15.70	16.50	0.80	5.1
Environmental Engineering	4.37	4.42	0.05	1.3
Systems Engineering for Large Structures.....	2.90	3.12	0.22	7.6
Natural and Man-Made Hazard Mitigation....	2.53	2.72	0.19	7.5
TOTAL, Subactivity....	\$36.20	\$43.05	\$ 6.85	18.9%

Specific areas that will be emphasized in FY 1987 include:

- o Establishment of a new program element in Computational Engineering at a level of \$3.0 million, focused on the interface between applied mathematics and the traditional engineering disciplines. This program includes activities dedicated to the discovery, development, and application of computer oriented algorithms to engineering problems and industrial processes. Computational engineering is to be distinguished from research using computers, where the primary emphasis is on calculating a scientific or engineering result, and from research on computers, where the primary emphasis is on developing new or advanced computer systems. Particular emphasis will be given to developing methodological approaches to fluid dynamics and earthquake simulations.
- o Grants for selected cross-disciplinary research teams in biotechnology to identify and solve key technical issues in applied biotechnology. New capabilities for directed control of biological systems are rapidly being developed through fundamental research in molecular and developmental

biology. In order to maintain the pace of translating these capabilities into practice, special efforts are required to promote collaboration between cell biologists and applied biotechnologists. A number of programs will be targeted to coordinate the research activities of engineers and life scientists.

- o Research on the effects of the September 1985 Mexican earthquake and the March 1985 Chilean earthquake on buildings and other structures will be expanded. Since numerous buildings that collapsed in these earthquakes were built to modern codes and with the latest technology in analysis, it is extremely important to analyze the failures that occurred. Support will also be provided to upgrade the analytical capability of earthquake engineering by increasing the use of supercomputers, and to begin using optical storage techniques for earthquake information transfer.
- o Continued support for one or two earthquake research centers to be established in FY 1986. The purpose of such a center is to study certain earthquake engineering problems in a more integrated manner and to provide a focus for special equipment or facilities. Each dollar NSF provides for the centers must be matched by state, industry, or other non-Federal support.
- o Methods for predicting the magnitude of extreme events, such as floods, high winds, ground failures, etc. for the purposes of engineering design to withstand or avoid them.

CHANGES IN BUDGET STRUCTURE

A new research program in Computational Engineering will be established in FY 1987.

CROSS-DISCIPLINARY RESEARCH..... \$38,000,000**SUMMARY OF REQUEST**

Support for the Cross-Disciplinary Research subactivity is increased by \$9.0 million or 31.0 percent. The changes in individual program elements are as follows:

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Engineering Research Centers.....	\$10,007,782	\$25,000,000	\$23,000,000	\$35,000,000	\$12,000,000
Industry/University Research Projects..	6,917,942	3,490,000	3,000,000	0	(3,000,000)
Industry/University Research Centers...	2,984,544	3,000,000	3,000,000	3,000,000	0
Total.....	\$19,910,268	\$31,490,000	\$29,000,000	\$38,000,000	\$9,000,000

SCIENTIFIC OVERVIEW

The Cross-Disciplinary Research (CDR) subactivity is the only effort within government aimed specifically at enhancing our country's international economic competitiveness by strengthening university-industry coupling in engineering research and education.

The effort in engineering research is pursued by focusing on engineering and scientific areas where the infusion of knowledge from several disciplines will enhance the probability of innovative and industrially relevant research. This need to improve the synergism between universities and industry in engineering research and education has been clearly established for some time.

There is currently a significant theoretical and analytical bias in engineering education in the United States. This bias has minimized the experimental, hands-on, and cross-disciplinary education needed to deal with a range of engineering problems facing, not only high technology industries, but mature industries as well. More emphasis is needed on the synthesis of engineering systems in order to improve the students' understanding of engineering practice. A major thrust of CDR is to strengthen this educational component in university-industry engineering research.

In pursuing this effort in strengthening engineering research and education, the subactivity has three broad objectives:

- o To improve the flow of fundamental engineering and scientific research between universities and industry;

- o To strengthen the links between university research engineers and scientists and their industrial counterparts in order to focus research on current and projected industry needs; and
- o To prepare students better in synthesizing, integrating and managing engineering systems.

Engineering Research Centers (ERC) aim at providing heightened research opportunities and an enhanced cross-disciplinary research environment in areas crucial to U.S. competitiveness in world markets; at upgrading engineering education, with an emphasis in training students in engineering systems; at promoting mechanisms for expanded interactions between industry and university researchers; and at facilitating and experimenting with new models for the dissemination of research results between universities and industry. The ERC concept is broad gauged in that it is designed to strengthen both research and education in engineering areas identified by universities and industries as being key in underpinning advances in U.S. technological capabilities over the long term.

The ERCs provide a mechanism for taking advantage of the combined strength of industrial and academic research capabilities by leapfrogging the barriers created by the traditional discipline orientation of U.S. engineering schools. The centers are cross-disciplinary and emphasize the systems aspects of engineering in undergraduate and graduate education and research, including the introduction of new courses relating to the research emphasis of the center. Industrial participation helps focus these activities on industry needs.

Already, more than 91 industrial firms are participating with the first six centers established under the program in FY 1985. Industrial support totals approximately \$13.0 million so far. State governments have also made significant contributions to the established centers. The effort is still a modest one, however, considering the demand for participation. Since its inception two years ago, a total of 244 ERC proposals have been received from 178 academic institutions. The aggregate of requests totalled \$3.6 billion over five years.

The six centers established during FY 1985 and their areas of emphases are:

- o University of California (Santa Barbara) -- Robotic Systems in Micro-electronics
- o Columbia University -- Telecommunications Research
- o University of Delaware -- Composites Manufacturing Science and Engineering
- o University of Maryland -- Systems Research
- o MIT -- Biotechnology Process Engineering
- o Purdue University -- Intelligent Manufacturing Systems

Industry/University Cooperative Research Centers (I/UC) seek to foster industry/university interaction by supporting basic and applied research at university centers. Compared to Engineering Research Centers, where the emphasis is on a strong and directed educational component associated with a research program that has a commitment for long-term NSF support, I/UC Centers direct their efforts at obtaining seed funds and organizational experience from NSF and highly leveraged industry, state and local government support.

The effort in support of Industry/University Cooperative Research Centers was initiated in 1973. Over the years it has sought to foster industry/university interaction on industrially relevant graduate science and engineering research topics and to provide a knowledge base for industrial and technological advancement. The NSF role is catalytic and these centers are expected to become self-sustaining with industry and state funding within a five year period.

As of October 1986, there will be about 40 operational centers, of which seven are self-supporting. Industrial and state support will be in excess of \$27 million, compared to NSF's \$3 million annual support. At the I/UC Center at North Carolina State University, a significant breakthrough in the communications field has been achieved. Softening or eliminating acoustical noise has been successfully studied, providing more exact cancellation of echo. Higher efficiency and lower costs in telecommunications systems should result from this research.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Engineering Research Centers.....	\$25.00	\$23.00	\$-2.00	-8.0%
Industry/University Cooperative Research Projects.....	3.49	3.00	-0.49	-14.0
Industry/University Cooperative Research Centers.....	3.00	3.00	0.00	0.0
TOTAL, Subactivity....	\$31.49	\$29.00	\$-2.49	-7.9%

The FY 1986 Current Plan of \$29.0 million is decreased by \$2.49 million or 7.9 percent from the FY 1986 Budget Request of \$31.49 million. The decrease reflects the results of two actions. First, Congress reduced NSF's budget request and the Engineering Activity shared in this reduction. Second, to maintain efforts in scientific research project support, funding for Engineering Research Centers and Industry/University Cooperative Research Projects was reduced. The latter program was decreased more since the trend over the last several budgets has been towards a reduction of the matching funds available, as research programs have assumed more of the funding responsibility for these projects.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Plan	FY 1987 Request	Difference	
			Amount	Percent
Engineering Research Centers.....	\$23.00	\$35.00	\$12.00	52.2%
Industry/University Cooperative Research Projects.....	3.00	0.00	-3.00	-100.0
Industry/University Cooperative Research Centers.....	3.00	3.00	0.00	0.0
TOTAL, Subactivity....	\$29.00	\$38.00	\$ 9.00	31.0%

The \$9.0 million increase in the FY 1987 Budget Request, to a total of \$38.0 million, represents a 31 percent increase over the FY 1986 Current Plan of \$29.0 million. The increase is devoted exclusively to the Engineering Research Centers (ERC) program. The Industry/University Cooperative Research Projects program is ended as an explicit matching fund within Engineering. Projects involving industry/university cooperation will continue to be supported through the disciplinary research programs Foundation-wide. This action completes the mainstreaming of this program with the ongoing research activities of the Foundation.

The heightening in support for the ERC program, from \$23.0 million in FY 1986 to \$35.0 million in FY 1987, will allow for modest budget increases for the existing centers, and for up to four new centers to be started in FY 1987. The projected funding support for the centers is the following:

ESTIMATED ANNUAL FUNDING FOR CENTERS IN EACH YEAR

(Millions of Dollars)

Centers started in:	FY 1985	FY 1986	FY 1987
FY 1985 (6 centers)	\$10.00*	\$13.69	\$15.06
FY 1986 (5 centers)	xx	9.31	10.24
FY 1987 (4 centers)	xx	xx	9.70
Total	\$ 10.00*	\$ 23.00	\$ 35.00

*9 months funding due to mid-year start

**BIOLOGICAL, BEHAVIORAL, AND
SOCIAL SCIENCES..... \$ 282,410,000**

SUMMARY OF REQUEST

The FY 1987 Request is 8.6% above the FY 1986 Current Plan.

Subjectivity	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
I. Molecular Biosciences.....	\$60,926,812	\$64,130,000	\$61,930,000	\$67,100,000	\$5,170,000
II. Cellular Biosciences.....	52,384,934	54,380,000	52,130,000	56,590,000	4,460,000
III. Biotic Systems and Resources.....	58,120,818	63,020,000	61,020,000	66,510,000	5,490,000
IV. Behavioral and Neural Sciences.....	44,378,478	47,130,000	45,690,000	48,870,000	3,180,000
V. Social and Economic Science.....	28,751,646	33,890,000	30,040,000	31,430,000	1,390,000
VI. Information Science and Technology..	8,948,007	9,500,000	9,260,000	11,910,000	2,650,000
Total.....	\$253,510,645	\$272,050,000	\$260,070,000	\$282,410,000	\$22,340,000

NSF ROLE

The Biological, Behavioral, and Social Sciences (BBS) research programs:

- o Advance knowledge of how living organisms grow, reproduce, and function and how life processes are initiated, regulated, and expressed;
- o Increase understanding of the ways chemical and physical events at the molecular and subcellular levels underlie fundamental life processes;
- o Provide insights into the interactions of biological systems and their environments and into the processes fundamental to the development of biological diversity, adaptation, and organic production;
- o Increase knowledge of the structures and functions of the nervous system and the biological and cultural factors that influence the behavior of humans and other animals;
- o Expand and improve the use of large-scale and other social and economic science data resources, and explain how various social and economic systems are organized and operate;
- o Advance understanding of the ways information is structured, transferred, and used; analyze the social and economic effects of rapid changes in information technology; and contribute to the knowledge base fundamental to the design of information systems.

Many research areas are multidisciplinary and cut across subactivity lines. For example, fundamental research in plant biology, for which NSF provides over 50 percent of all Federal support, includes studies of the molecular structure and function of plant cells, supported by both the Cellular and the Molecular Biosciences Subactivities. It also includes research on plant distribution, plant-plant, and plant-environment interactions, supported by Biotic Systems and Resources. The Department of Agriculture is the second largest source of Federal support for investigator-initiated fundamental research on plants. Its role is complementary to NSF's and focuses on research on problems of crop productivity.

In the broader area of research related to biotechnology, support spans five of the six subactivities within BBS. Research support ranges from multidisciplinary research linking biologists and chemists to development of better research methodologies for assessing the risk of these technologies.

Across the biological sciences, NSF accounts for about 15 percent of all Federal obligations for basic research performed at colleges and universities. The National Institutes of Health (NIH) provide the largest share of Federal funds (about 75 percent) for research in biology, most of which is related to specific diseases or disorders and is outside NSF's purview.

NSF provides about 90 percent of all Federal support for basic research in environmental biology performed at academic institutions. Research supported provides the scientific base for addressing questions about biological productivity, resource management, and ecology.

NSF provides about 10 percent of the Federal total for basic research in neuroscience. Its distinctive role is to focus on cutting-edge research questions about the structure and function of nervous systems, using both vertebrate and invertebrate animal models.

In the behavioral and social sciences, the Foundation accounts for about 24 percent of all Federal obligations for basic research performed at colleges and universities, and ranks third behind the Departments of Health and Human Services and Defense. In the social sciences NSF provides the largest share (38 percent) of support for basic research at colleges and universities. A major NSF contribution is to the growing quantitative focus in the social sciences through its support of data collection and in the development and refinement of research methods.

In some areas of behavioral and social science research, NSF is almost the sole source of support for academic basic research, providing 95 percent of all Federal support for academically-based research in both anthropology and political science.

NSF is the only source of non-mission Federal support for information science research and the major supporter of multidisciplinary research on information science. Research supported by the Department of Defense (DOD) concentrates on requirements for command, control, and intelligence systems and on administrative and office systems; DOD human factors research deals with the design of weapons systems. The National Library of Medicine support of information science research focuses on medical information systems and problems.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

The FY 1986 Current Plan of \$260.07 million is a \$11.98 million, or 4.4%, decrease from the Budget Request of \$272.05 million.

(Millions of Dollars)

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Molecular Biosciences...	\$64.13	\$61.93	-\$2.20	-3.4%
Cellular Biosciences....	54.38	52.13	-2.25	-4.1
Biotic Systems and Resources.....	63.02	61.02	-2.00	-3.2
Behavioral and Neural Sciences.....	47.13	45.69	-1.44	-3.1
Social and Economic Science.....	33.89	30.04	-3.85	-11.4
Information Science and Technology.....	9.50	9.26	-0.24	-2.5
TOTAL, Activity.....	\$272.05	\$260.07	-\$11.98	-4.4%

The reduction of \$11.98 million from the FY 1986 Budget Request will still result in an increase of \$6.6 million over FY 1985. The reduction from the FY 1986 Request will result in the following changes from expected activities:

- o lowered support for instrumentation throughout the subactivities;
- o a reduction in the number of awards for FY 1986, and a slight reduction in support for presidential young investigators;
- o a reduction of \$2.75 million in the planned \$6.0 million increase for research related to biotechnology;
- o and a partial reduction in the increase originally proposed to support new data collections and resources in the social and economic sciences; the FY 1986 Current Plan will still reflect an increase of 4.5% over FY 1985.

FY 1987 BUDGET HIGHLIGHTS*(Millions of Dollars)*

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Molecular Biosciences...	\$61.93	\$67.10	\$ 5.17	8.4%
Cellular Biosciences....	52.13	56.59	4.46	8.6
Biotic Systems and Resources.....	61.02	66.51	5.49	9.0
Behavioral and Neural Sciences.....	45.69	48.87	3.18	7.0
Social and Economic Science.....	30.04	31.43	1.39	4.6
Information Science and Technology.....	9.26	11.91	2.65	28.6
TOTAL, Activity.....	\$260.07	\$282.41	\$22.34	8.6%

The ongoing emphasis on research related to biotechnology in five of the six BBS subactivities will increase significantly in FY 1987. In addition to increasing regular research grant support in the most critical basic research areas--such as microbial ecology in the Biotic Systems and Resources Subactivity and risk assessment in the Social and Economic Sciences--the FY 1987 emphasis will establish a series of biotechnology centers. These will include two to four large, interdisciplinary research centers and up to ten departmental, multiuser instrumentation facilities. Support will also increase for cross-disciplinary research training.

Instrumentation support will increase in all subactivities. In the biological sciences, one major focus will be the provision of large and multiuser, shareable items of equipment; another will be upgrading biological field stations. In the behavioral, social and information sciences, support will generally increase for the acquisition of computers more powerful than microcomputers, to support the increasingly heavy use of computational techniques and modeling in these fields.

Support will increase across subactivities for mathematical modeling, computer simulation, image analysis and the use of computer graphics. Enhanced activities will include such topics as biological process simulation, mathematical modeling of cognitive and social processes, and image analysis in the neurosciences.

Increased support for global geosciences in Biotic Systems and Resources will expand the NSF Long-Term Ecological Research Network. It will also increase the use of remotely sensed data in research on ecosystem dynamics and the study of the biological processes controlling biogeochemical cycles.

In the Information Science and Technology Subactivity, increased support will go to research related to advanced computers, such as distributed systems and parallel processing machines. This will include research on machine learning, advanced knowledge retrieval systems, and computable models of language and discourse.

Several major NSF emphases begun in prior years will continue. The emphasis on plant biology will continue across the Biotic Systems and Resources and the Cellular and the Molecular Biosciences Subactivities, including the highly successful Plant Postdoctoral Program. The neurosciences will continue to emphasize the development of brain structure and function and the biochemical bases of neural activity and behavior. Support will continue for the important national data bases previously supported by the Social and Economic Science Subactivity. The emphasis on research related to the processes of teaching and learning will continue across multiple subactivities.

The important NSF role of stimulating the refinement of data collection and handling techniques, particularly in the behavioral and social sciences, will be maintained. This includes the development of archaeological artifact dating techniques, and various behavioral and social science measurement tools and methods.

Finally, an increased emphasis across subactivities will provide real research experiences for undergraduate students and faculty as part of an NSF-wide program.

CHANGES IN BUDGET STRUCTURE

For the FY 1987 Budget Request, the budget structure for three subactivities, Biotic Systems and Resources, Behavioral and Neural Sciences, and Social and Economic Science, has been modified to reflect more accurately the programmatic structure and activities within each subactivity. The program element and program subelement structures used in the FY 1986 Budget Request have been combined in the FY 1987 Request.

MOLECULAR BIOSCIENCES..... \$67,100,000**SUMMARY OF REQUEST**

The FY 1987 Request is 8.4% above the FY 1986 Current Plan.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Biological Instrumentation.....	\$8,017,766	\$8,410,000	\$8,300,000	\$10,000,000	\$1,700,000
Biochemistry.....	13,960,935	15,749,000	15,130,000	16,090,000	960,000
Biophysics.....	13,721,348	15,310,000	14,700,000	15,800,000	1,100,000
Prokaryotic Genetics.....	8,231,474	8,960,000	8,800,000	9,660,000	860,000
Metabolic Biology.....	14,522,109	15,701,000	15,000,000	15,550,000	550,000
Alternative Biological Resources.....	2,473,180	0	0	0	0
Total.....	\$80,926,812	\$64,130,000	\$61,930,000	\$67,100,000	\$5,170,000

SCIENTIFIC OVERVIEW

The Molecular Biosciences Subactivity advances biological knowledge through increasing understanding of the chemical and physical processes underlying fundamental biological phenomena by supporting research at the molecular and subcellular levels. The special focus of the Molecular Biosciences Subactivity is on research leading to advances in plant molecular biology, biotechnology, interdisciplinary approaches to problems involving the physical and chemical sciences, and the elaboration of molecular mechanisms in simple, model biological systems.

Contemporary molecular bioscience requires sophisticated instrumentation and, thus, continuing investment in research equipment. Experimental and theoretical approaches in the molecular biosciences have been profoundly stimulated by advances in the physical and chemical sciences, permitting new interdisciplinary approaches to the elaboration of the molecular mechanisms underlying biological processes. Joint consideration and support of meritorious research and equipment is most common with the Cellular Biosciences and the Chemistry Subactivities, but also occurs regularly with Engineering, Materials Research and other related efforts of the Foundation.

The molecular biosciences are a vital contributor to biotechnology, and the research supported includes some of the most rapidly advancing areas of science. The study of the structure, function and regulation of genes and how they may be moved from one biological system to another, using the techniques of recombinant DNA, provides the foundation for new production methods for important biochemicals. Similarly, research in plant molecular biology has advanced the understanding of mechanisms underlying plant metabolism, transport processes, photosynthesis, and nitrogen fixation and will provide the basis for improved agriculture.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Biological Instrumenta- tion.....	\$8.41	\$ 8.30	-\$0.11	-1.3%
Biochemistry.....	15.75	15.13	- 0.62	-3.9
Biophysics.....	15.31	14.70	- 0.61	-4.0
Prokaryotic Genetics....	8.96	8.80	- 0.16	-1.8
Metabolic Biology.....	15.70	15.00	- 0.70	-4.5
TOTAL, Subactivity....	\$64.13	\$61.93	-\$2.20	-3.4%

The difference between the 1986 Request and the 1986 Current Plan, -\$2.20 million, a reduction from the Request of 3.4%, resulted from an unspecified Congressional reduction. In allocating these reductions across program elements, priority was given to multiuser instrumentation, instrumentation development and to fundamental research pivotal to biotechnology. These priorities are consistent with those enunciated in the 1986 Request. Reductions were thus made in lower priority activities and do not uniformly affect size or number of awards across program elements.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change FY 1987/FY 1986	
			Amount	Percent
Biological Instrumenta- tion.....	\$ 8.30	\$10.00	\$ 1.70	20.5%
Biochemistry.....	15.13	16.09	0.96	6.4
Biophysics.....	14.70	15.80	1.10	7.5
Prokaryotic Genetics....	8.80	9.66	0.86	9.8
Metabolic Biology.....	15.00	15.55	0.55	3.7
TOTAL, Subactivity.....	\$61.93	\$67.10	\$ 5.17	8.4%

Ongoing emphases that will continue across all program elements include: (1) needed laboratory resources and instrumentation; (2) research in plant molecular biology; (3) innovative genetic approaches to key research problems in molecular biology; (4) research at predominantly undergraduate institutions; and (5) research conducted by women, minority and handicapped scientists.

Significantly enhanced support for research related to biotechnology presents unique opportunities for molecular bioscience. A large portion of these funds will assist in the establishment of both large and small biotechnology centers, with each center to be equipped for contemporary molecular research. The Biological Instrumentation Program will play a key role in helping to establish these centers. Support will also increase for interdisciplinary research and training that is pivotal to cross-disciplinary efforts in biotechnology, e.g., research in molecular structure at the interface of biology, chemistry and engineering.

Another focus of increased support will be molecular modeling and verification of the structure of key components of biological systems. The Biophysics Program will play a key role in the collaborative multidisciplinary approaches central to computational science and engineering.

Increased sophistication of biomolecular research depends on increased attention to two kinds of laboratory instrumentation support: for purchase of required state-of-the-art equipment to replace outdated models; and for the development of new instruments that extend current measurement capability or performs functions made feasible by new technologies. Increases in all program elements will contribute to the upgrading of laboratory equipment, and an emphasis in the Biological Instrumentation Program will be the development of new instruments.

CELLULAR BIOSCIENCES..... \$ 56,590,000**SUMMARY OF REQUEST**

The FY 1987 Request is 8.6% above the FY 1986 Current Plan.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Cell Biology.....	\$11,645,370	\$11,670,000	\$11,200,000	\$12,180,000	\$980,000
Cellular Physiology.....	8,213,729	8,650,000	8,100,000	9,020,000	920,000
Developmental Biology.....	13,390,289	14,640,000	14,010,000	14,970,000	960,000
Eukaryotic Genetics.....	8,658,345	9,220,000	9,040,000	10,040,000	1,000,000
Regulatory Biology.....	10,477,193	10,200,000	9,780,000	10,380,000	600,000
Total.....	\$52,384,934	\$54,380,000	\$52,130,000	\$56,590,000	\$4,460,000

SCIENTIFIC OVERVIEW

Research in the Cellular Biosciences is directed toward providing answers to long-standing biological questions concerning how plants, animals, and microorganisms develop, grow, reproduce, and function, and how life processes are initiated, regulated, controlled, expressed, and integrated at the level of the gene, cell, and organism. Specific areas include various aspects of genetic biology, cell structure and function, cell to cell relationships, molecular mechanisms underlying cellular development, control of immune responses, mechanisms of hormone action, and physiological regulation.

A continuing major emphasis is the cellular biology of plant systems, especially areas where fundamental information is needed, such as plant genetics, cell culture, and embryo development. Many biological questions at the cellular level can be answered only with chemical approaches. Thus, collaborative research at the interface of biology and chemistry is also emphasized. The use of a wide range of organisms as biological models is encouraged as there is a rich array of relatively uninvestigated organisms that offer advantageous systems to focus on important problems in the cellular biosciences. The value of using a wide spectrum of organisms in research across the biological sciences has been stressed in a recent (1985) report from the National Academy of Sciences entitled "Models for Biomedical Research: A New Perspective."

Major scientific advances are currently being made in all areas of the cellular biosciences due largely to the availability of sophisticated new biotechnologies and advanced instrumentation. These include recombinant DNA, monoclonal antibody, and cell culture technologies, and instrumentation such as DNA sequencers, electron microscopes, fluorescence-activated cell sorters, cell culture apparatus, and controlled environmental chambers. Basic research in the cellular biosciences not only depends upon the utilization of such methodologies, but also often provides the groundwork for the subsequent development of entirely new biotechnological approaches and tools.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Cell Biology.....	\$11.67	\$11.20	-\$0.47	-4.0%
Cellular Physiology.....	8.65	8.10	- 0.55	-6.4
Developmental Biology...	14.64	14.01	- 0.63	-4.3
Eukaryotic Genetics.....	9.22	9.04	- 0.18	-2.0
Regulatory Biology.....	10.20	9.78	- 0.42	-4.1
TOTAL, Subactivity....	\$54.38	\$52.13	-\$2.25	-4.1%

The difference between the 1986 Request and the 1986 Current Plan is -\$2.25 million, or a reduction of 4.1 percent, resulting from an unspecified Congressional reduction. Reductions were made in lower priority areas and were distributed to protect specific emphases in plant biology, genetic and other biotechnological approaches, and instrumentation.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Cell Biology.....	\$11.20	\$12.18	\$ 0.98	8.8%
Cellular Physiology.....	8.10	9.02	0.92	11.4
Developmental Biology...	14.01	14.97	0.96	6.9
Eukaryotic Genetics.....	9.04	10.04	1.00	11.1
Regulatory Biology.....	9.78	10.38	0.60	6.1
TOTAL, Subactivity....	\$52.13	\$56.59	\$ 4.46	8.6%

Prior year emphases will continue in plant biology, the application of genetic and immunological techniques to fundamental problems in the cellular biosciences, and the purchase of equipment for individual researchers. Young investigators will be supported through not only the Presidential Young Investigator Program, but also the Plant Postdoctoral Program and first awards to beginning investigators. Support for research at undergraduate institutions and for women and minority scientists has been a priority and will continue to be so. The retraining of senior investigators in contemporary technology through small supplements to active awards will continue at a modest level.

An emphasis on biotechnology-related activities will involve increased research support in many

program elements and support for the establishment of large and small biotechnology centers where multidisciplinary teams can interact. A major focus for research related to biotechnology will be plant biology, which continues to require scientists thoroughly trained in contemporary technology. There will be a continued effort jointly with the Molecular Biosciences Subactivity to attract outstanding young scientists to plant biology through postdoctoral research awards.

All programs require advanced instrumentation to enable scientists to conduct state-of-the-art research. Expanded support for instrumentation will be provided through individual research grants for upgrading or replacing existing equipment, such as spectrophotometers and microscopes, for acquiring new advanced instrumentation, such as DNA sequencers and cell sorters, and for supplying microcomputer technology considered essential for rapid progress in automation, analysis, and simulation.

Support will increase for research applying mathematical or engineering approaches to problems in the cellular biosciences. Emphases will be on mathematical modeling, computer simulation, image analysis, and computer graphics predominantly for cellular (muscle contraction, mechanisms of cell motility, membrane excitation dynamics) and physiological (bioengineering analysis of locomotion, fluid dynamics of circulation) processes most amenable to such approaches.

BIOTIC SYSTEMS AND RESOURCES.....\$ 66,510,000**SUMMARY OF REQUEST**

The FY 1987 Request is 9.0% above the FY 1986 Current Plan.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Ecology.....	\$8,885,543	\$10,050,000	\$9,731,900	\$10,930,000	\$1,198,100
Ecosystem Studies.....	17,393,221	19,300,000	18,687,440	20,790,000	2,102,560
Systematic Biology.....	12,231,493	13,023,300	12,611,000	13,450,000	839,000
Population Biology and Physiological Ecology.....	10,212,310	10,667,500	10,329,000	11,180,000	851,000
Biological Research Resources.....	9,398,251	9,978,300	9,660,650	10,160,000	499,340
Total.....	\$58,120,818	\$63,020,000	\$61,020,000	\$66,510,000	\$5,490,000

SCIENTIFIC OVERVIEW

Research in Biotic Systems and Resources seeks to increase understanding of the interrelationships of organisms as they exist in nature. Studies of ecological relationships examine those processes linking together plants, animals, microorganisms, and the nonliving parts of their ecosystems--soil, air, water. Scientists also seek to determine the basic hereditary interrelationships of organisms, both living and extinct, so as to trace their organic histories and establish schemes for their classification. Research supported by this subactivity provides the scientific framework within which the problems of biological productivity, natural resources, and land use management can be addressed.

Ecological relationships are examined at several levels of organization--biological community, ecosystem, biogeographic region, and biosphere (the global ecosystem). Microbial ecology is currently one topic of particular emphasis. It concerns interactions of soil microbes with plant roots and soil-living invertebrate animals. At the biogeographic level, increasing attention is being directed to the dynamics of ecological relationships undergoing long-term and periodic environmental changes. On a larger scale, biospheric-level studies are focusing on biogeochemistry--the role of living organisms in the cycling of nutrient elements (such as carbon, nitrogen, and sulfur), soil, water and the atmosphere.

Systematic and population biology seek to determine trait similarities within and among groups of plants, animals, and microorganisms. Research using a variety of newer molecular and mathematical techniques is revising and challenging many long-standing ideas. Current interest in the nature and genetic structure of microbial populations builds upon similar studies on both plant and animal species that seek to understand the linkage between genetic makeup and environmental adaptability.

Support in this subactivity is also provided for the development and maintenance of biological research resources, such as systematic collections, stock centers, field research facilities, and controlled environmental laboratories.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Ecology.....	\$10.05	\$ 9.73	-\$ 0.32	-3.2%
Ecosystem Studies.....	19.30	18.69	- 0.61	-3.2
Systematic Biology.....	13.02	12.61	- 0.41	-3.1
Population Biology & Physiological Ecology..	10.67	10.33	- 0.34	-3.2
Biological Research Resources.....	9.98	9.66	- 0.32	-3.2
TOTAL, Subactivity....	\$63.02	\$61.02	-\$ 2.00	-3.2%

The difference between the 1986 Request and the Current Plan, -\$2.0 million, is the result of an unspecified Congressional reduction. These reductions are distributed proportionally across program elements. Grant size is being protected and, as a consequence, fewer new research projects will be initiated in all areas.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Ecology.....	\$ 9.73	\$10.93	\$1.20	12.3%
Ecosystem Studies.....	18.69	20.79	2.10	11.3
Systematic Biology.....	12.61	13.45	0.84	6.7
Population Biology & Physiological Ecology	10.33	11.18	0.85	8.2
Biological Research Resources.....	9.66	\$10.16	0.50	5.2
TOTAL, Subactivity....	\$61.02	\$66.51	\$5.49	9.0%

The ecological sciences, augmented overall by \$3.30 million, will continue to emphasize research on microbial ecology, the role of microorganisms in the biogeochemical cycling of sulfur, nitrogen, and carbon, and the role of plant chemicals as deterrents of insect plant feeding, and other ecosystem processes. Continuation of the research emphases in Systematic Biology, and Population Biology and Physiological Ecology will be sustained by an increase of \$1.69 million. These include research on plant biology, especially the use of molecular genetic techniques to elucidate biological diversity, and the adaptation of plants to nutrient-poor soils.

The Subactivity will continue its postdoctoral fellowship program to attract talented personnel to high priority research areas in environmental biology, especially microbial ecology and the application of molecular techniques to ecological problems.

Support for research in microbial ecology and other activities related to biotechnology will increase across the Subactivity to develop a broader information base for understanding the ecological consequences of the deliberate release of genetically engineered organisms.

Increased emphasis on global geosciences, particularly in the Ecosystem Studies Program, will expand the network of Long-Term Ecological Research (LTER) sites to provide a more complete geographic basis for studying biological and ecological phenomena over extended space and time scales. It will also provide for increased use of remotely sensed data at LTER and other sites to enhance research on ecosystem dynamics, such as global geochemistry, biological diversity and productivity.

The need for advanced instrumentation will be addressed in part by increased equipment support in all programs. Advances are dependent upon equipment required in molecular genetic analysis (of microbial ecology and biological diversity, for example) and in the measurement of circulation and accumulation of chemical elements and trace chemical substances whose fluxes are mediated by biological processes.

Additional emphasis on the upgrading of instrumentation and other facilities at biological field stations augments the budget of the Biological Research Resources Program.

CHANGES IN BUDGET STRUCTURE

The FY 1986 Budget Request was structured in two program elements (Ecological Sciences and Systematic and Population Biology) with a total of five program subelements, corresponding to the research programs within the BSR subactivity. The FY 1987 Budget Request presents those five as program elements. This change was made to reduce unnecessary redundancy and improve clarity.

BEHAVIORAL AND NEURAL SCIENCES..... \$ 48,870,000**SUMMARY OF REQUEST**

The FY 1987 Request is 7.0% above the FY 1986 Current Plan.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Anthropology.....	\$7,409,446	\$7,300,000	\$7,300,000	\$7,780,000	\$480,000
Linguistics.....	3,271,914	3,220,000	3,150,000	3,300,000	150,000
Memory and Cognitive Processes.....	4,771,970	4,600,000	4,000,000	4,200,000	200,000
Social and Developmental Psychology.....	3,130,648	3,210,000	3,150,000	3,300,000	150,000
Developmental Neuroscience.....	4,971,736	5,650,000	5,550,000	6,150,000	600,000
Integrative Neural Systems.....	4,355,520	5,700,000	5,100,000	5,500,000	400,000
Molecular and Cellular Neurobiology.....	4,983,898	5,550,000	5,550,000	6,150,000	600,000
Psychobiology.....	4,742,135	4,730,000	4,730,000	5,030,000	300,000
Sensory Physiology and Perception.....	6,741,161	7,650,000	7,160,000	7,460,000	300,000
Total.....	\$44,378,428	\$47,130,000	\$45,690,000	\$48,870,000	\$3,180,000

SCIENTIFIC OVERVIEW

Research in the behavioral and neural sciences advances understanding of the biological, environmental, and cultural factors that underlie the behavior of human beings and animals, with explicit emphasis on nervous system structure and function. A wide variety of techniques are required to analyze these relationships, at levels ranging from the molecular to the cultural.

Research on the nervous system seeks to understand nerve cell action, the growth and development of the nervous system, and the underlying anatomical, physiological and biochemical aspects of nervous system function. Progress at the cellular and molecular levels has been especially rapid in recent years. At present, special emphasis is being placed on collaboration between chemists and biologists studying questions of nervous system function.

Research in the cognitive sciences provides increased understanding of how human beings acquire, store, retrieve, and use information; the general properties of language and how it is acquired and used; and the complex behavior of people, including the development of their behavior. There is a continuing emphasis on basic research with clear implications for the teaching and learning of science and mathematics.

Anthropology seeks to discover the laws or regularities underlying differences and similarities among human societies. NSF supports research on contemporary and ancient cultures, human physical diversity, the origin of man, and the interaction

between biological and social characteristics of humans. NSF also provides support to preserve and to increase accessibility to major research collections in anthropological museums. Recently, NSF began a special competition to support the development and utilization of new archaeometric (sample dating) techniques to increase understanding of past cultures through analyses of their material remains.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Anthropology.....	\$7.30	\$7.30	\$0.00	0.0%
Linguistics.....	3.22	3.15	- 0.07	- 2.2
Memory & Cognitive Processes.....	4.60	4.00	- 0.60	-13.0
Social and Developmental Psychology.....	3.23	3.15	- 0.08	- 2.5
Developmental Neuroscience	5.65	5.55	- 0.10	- 1.8
Integrative Neural Systems	5.20	5.10	- 0.10	- 1.9
Molecular and Cellular Neurobiology.....	5.55	5.55	0.00	0.0
Psychobiology.....	4.73	4.73	0.00	0.0
Sensory Physiology and Perception.....	7.65	7.16	- 0.49	- 6.4
TOTAL, Subactivity.....	\$47.13	\$45.69	-\$1.44	- 3.1%

The difference between the 1986 Request and the 1986 Current Plan, -\$1.44 million, results from an unspecified Congressional reduction. The distribution of the decrease reflects judgments made on the basis of expected proposal load, adjustments in lower priority research areas, and the need to respond to special areas of opportunity, particularly pressing in aspects of the neurosciences and in anthropology. While the strong commitment to support basic research with clear implications for teaching and learning of science and mathematics continues, the percent change in Memory and Cognitive Processes is relatively high because of the large commitment of funds for such research in FY 1985 and a resulting anticipated decrease in proposal submissions for FY 1986.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Anthropology.....	\$7.30	\$7.78	\$0.48	6.6%
Linguistics.....	3.15	3.30	0.15	4.8
Memory & Cognitive Processes	4.00	4.20	0.20	5.0
Social & Developmental Psychology.....	3.15	3.30	0.15	4.8
Developmental Neurosciences.....	5.55	6.15	0.60	10.8
Integrative Neural Systems.....	5.10	5.50	0.40	7.8
Molecular and Cellular Neurobiology.....	5.55	6.15	0.60	10.8
Psychobiology.....	4.73	5.03	0.30	6.3
Sensory Physiology & Perception.....	7.16	7.46	0.30	4.2
TOTAL, Subactivity....	\$45.69	\$48.87	\$3.18	7.0*

The requested increase in Anthropology will continue the emphasis on research on human origins and efforts to improve artifact collections management at colleges and universities and data handling techniques throughout the field. The special emphasis on developing and refining techniques for dating and analyzing archaeological artifacts will continue.

The requested increase across the three cognitive science program elements (totalling \$500,000 over Linguistics, Memory and Cognitive Processes, and Social and Developmental Psychology), will continue emphases on research related to the processes of teaching and learning of science and mathematics; the development of cognitive abilities and language usage; the socialization of children; the relation of language use and other cognitive functions to underlying neural processes; and computer simulation studies of human knowledge representation.

The requested increase across the five neuroscience program elements (totalling \$2.2 million) permits continuing emphases on the development of brain structure and function; the biochemical bases of brain function and behavior; the processing of sensory signals by the nervous system; and the application of advanced biotechnologies and instrumentation to questions of neural development, organization and activity.

Support for state-of-the-art equipment will increase in all program areas, particularly in the neurosciences, where analytical instruments from the physical sciences are increasingly being used in the study of brain structure and function. The

establishment of departmental instrumentation facilities for biotechnology will significantly aid the application of new techniques and instrumentation to neuroscience research. Increased instrumentation support in the cognitive sciences will further aid the use of quantitative models in understanding linguistic, cognitive and social processes.

Emphasis will increase across program elements on research on the biobehavioral processes underlying learning and memory, an area now particularly ripe for major breakthroughs in understanding. For example, researchers are now beginning to unravel the physiological mechanisms underlying memory and the ways learning experiences affect the brain.

CHANGES IN BUDGET STRUCTURE

The FY 1986 Budget Request was structured in three program elements (Anthropology, Cognitive Science, and Neuroscience) with a total of nine program subelements, corresponding to the research programs within the BNS subactivity. The FY 1987 Budget Request presents those nine programs as program elements. This change was made to reduce unnecessary redundancy and improve clarity.

SOCIAL AND ECONOMIC SCIENCE..... \$ 31,430,000**SUMMARY OF REQUEST**

The FY 1987 Request is 4.6% above the FY 1986 Current Plan.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Economics.....	\$10,065,136	\$14,340,000	\$12,000,000	\$12,600,000	\$600,000
Geography.....	1,292,700	1,600,000	1,600,000	1,680,000	80,000
Sociology.....	4,604,916	4,200,000	3,700,000	3,800,000	100,000
Measurement Methods and Data Improvement.....	3,387,326	3,800,000	3,700,000	3,700,000	0
History and Philosophy of Science.....	1,704,490	2,200,000	1,620,000	1,750,000	130,000
Political Science.....	3,314,788	4,100,000	3,700,000	3,800,000	100,000
Law and Social Sciences.....	1,902,361	2,200,000	1,620,000	1,750,000	130,000
Regulation and Policy Analysis.....	1,089,998	0	0	0	0
Decision and Management Science.....	1,389,931	1,450,000	2,100,000	2,350,000	250,000
Total.....	\$28,751,646	\$33,890,000	\$30,040,000	\$31,430,000	\$1,390,000

SCIENTIFIC OVERVIEW

The Social and Economic Science Subactivity supports disciplinary and interdisciplinary research on human social behavior and social organizations and systems. The scope of this research ranges from studies of market behavior and business decision making to analyses of internal migration patterns and population dynamics. The Subactivity also maintains major collections of high quality social science data and supports research on social measurement and the statistical methods used in data analysis. The projects supported are of three types: basic research, measurement and methodological research, and large scale data collection. In each area, NSF plays a critical role not duplicated elsewhere.

Social and Economic Science Programs seek to extend the data available for research by improving the scientific utility of Federal statistical data and to advance the statistical and analytical power of the social and economic sciences by focusing on longitudinal and over-time data. In addition, NSF supports original data collection in three national data resources and a number of smaller data collection efforts.

The social and economic sciences are experiencing a major expansion at the present time, shifting from research on the individual to an integration of the study of the individual with that of organizations and institutions. Over the past two decades, we have learned to analyze human behavior patterns in great depth relying heavily upon data from survey research. This has been directly dependent upon the increased availability of longitudinal

data and advances in such areas as statistics, the use of models in social analysis, and the reduction of non-sampling error in sample surveys. Social scientists are now emphasizing the study of the individual in interaction with others in formal and informal organizations and in social and economic institutions. This broadening of the focus of social science research recognizes the importance of social structures and organizations in determining behavior.

CHANGES BETWEEN THE 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Economics	\$14.34	\$12.00	- \$2.34	-16.3%
Geography	1.60	1.60	0.00	0.0
Sociology	4.20	3.70	- 0.50	-11.9
Measurement Methods and Data Improvement...	3.80	3.70	- 0.10	- 2.6
History and Philosophy of Science	2.20	1.62	- 0.58	-26.4
Political Science	4.10	3.70	- 0.40	- 9.8
Law and Social Sciences.	2.20	1.62	- 0.58	-26.4
Decision & Management Science	1.45	2.10	0.65	+44.8
TOTAL, Subactivity....	\$33.89	\$30.04	- \$3.85	-11.4%

The overall difference between the Fiscal Year 1986 Budget Request and the 1986 Current Plan, -\$3.85 million, reflects an unspecified Congressional reduction. The current plan for Decision and Management Science is increased \$650,000 above the Budget Request to expand support for research on decisionmaking under risk and uncertainty and principles of risk assessment. Under the current plan, Economics will continue the projected support of the Panel Study on Income Dynamics (PSID) and its emphasis on microeconomics and industrial organization. However, it will not be able to launch any major new data collection projects or undertake other large scale research initiatives. Other Program Elements will be limited to maintenance of key national data resource projects and research in core areas. Increased support had been requested in the FY 1986 Budget Request for research on the role of legal structures in the development of the state in the Law and Social Sciences Program Element and for an increased emphasis on the history of technology in the History and Philosophy of Science Program Element. However, due to the unspecified Congressional reduction, these emphases will be delayed until FY 1987.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Economics	\$12.00	\$12.60	\$0.60	5.0%
Geography	1.60	1.68	0.08	5.0
Sociology	3.70	3.80	0.10	2.7
Measurement Methods and Data Improvement.....	3.70	3.70	0.00	0.0
History and Philosophy of Science	1.62	1.75	0.13	8.0
Political Science	3.70	3.80	0.10	2.7
Law and Social Sciences.	1.62	1.75	0.13	8.0
Decision & Management Science	2.10	2.35	0.25	11.9
TOTAL, Subactivity....	\$30.04	\$31.43	\$1.39	4.6*

The FY 1987 Request will maintain support for three major national data bases (the Panel Study of Income Dynamics, the General Social Survey, and the National Election Studies); new data collection will begin in other areas of theoretical and methodological importance.

The increase across the Economics and the Geography and Regional Science Program Elements, totalling \$680,000, will continue support for theoretical and empirical research and maintain the new emphasis on physical geography. These funds will also support initial steps toward the establishment of a National Geographical Information Center, which would concentrate on computerized map information storage, manipulation, and display. The center would improve spatial statistics and provide opportunities for research on population and economic change and on graphic perception.

The increase across the Sociology, Measurement Methods and Data Improvement, and History and Philosophy of Science Program Elements, totalling \$230,000, will go to maintain an emphasis on methodological research and the history of technology. A new emphasis will begin across program elements on methodological research and data collection on firms and organizations.

The increase across the Decision and Management Science, Law and Social Sciences, and Political Science Program Elements, totalling \$480,000, will continue support for data collection and analysis in these areas. Support will increase for the study of the role of domestic politics, political structures, and legal systems in the development of international markets and politics, subjects with both theoretical and practical implications.

The Economics and Political Science Program Elements contain additional funds for the support of computer modeling and simulation. The Decision and Management Science Program Element has increased funds for risk assessment, including, but not limited to, risk assessment in the area of biotechnology.

CHANGES IN BUDGET STRUCTURE

The budget structure of the Division of Social and Economic Science now consists of eight Program Elements instead of the previous three. This change resulted from the reorganization of the Division in September, 1985, in which the three sections (called Program Elements in the FY 1986 Budget Request) were eliminated for reasons of managerial efficiency. The eight research programs in the Division were not changed and appear in the FY 1987 Request as Program Elements rather than as subelements.

BBS - V - 4

INFORMATION SCIENCE AND TECHNOLOGY..... \$ 11,910,000**SUMMARY OF REQUEST**

The FY 1987 Request is 28.6% above the FY 1986 Current Plan.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Information Science.....	\$5,192,846	\$5,500,000	\$5,170,000	\$6,910,000	\$1,540,000
Information Technology.....	1,793,729	2,000,000	1,945,000	2,500,000	555,000
Information Impact.....	1,761,432	2,000,000	1,945,000	2,500,000	555,000
Total.....	\$8,948,007	\$9,500,000	\$9,260,000	\$11,910,000	\$2,650,000

SCIENTIFIC OVERVIEW

The Information Science and Technology Subactivity covers a multidisciplinary field dealing with the nature of information, its generation, representation, manipulation, use and effect. Support is provided in three highly related program elements.

The Information Science Program emphasizes theoretical work on automated pattern recognition, machine learning, automated decision support systems, knowledge representation, and information retrieval. It intersects with basic cognitive and computer sciences, but focuses on information processing as an underlying feature of biological and electronic systems, and on analysis of structural properties of information collections. Traditionally highly theoretical, the field has become more experimental and empirical with the increasing availability of advanced technology, and the need to test theory directly in operational implementations of theoretically interesting ideas.

The Information Technology Program focuses on creating a knowledge base for the design and operation of information processing systems. It supports experimentation on the generation, integration, transfer, retrieval, and display of information, on interactions between human and information systems, and on the modeling of the performance of information systems.

The Information Impact Program supports work on information and information technology as a factor in economic, organizational and social processes. It examines such issues as the organizational effects of office automation, economic productivity and labor force effects of robotics, and structural changes in information-intensive industries.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Information Science.....	\$5.50	\$5.37	-\$0.13	- 2.4%
Information Technology..	2.00	1.94	- 0.06	- 3.0
Information Impact.....	2.00	1.95	- 0.05	- 2.5
TOTAL, Subactivity....	\$9.50	\$9.26	-\$0.24	- 2.5%

The reduction from the FY 1986 request is \$240,000 and results from the unspecified Congressional reduction. It is allocated equally across the programs and reduces the number of awards to be made, but protects grant size.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Information Science.....	\$ 5.37	\$ 6.91	\$1.54	28.7%
Information Technology..	1.94	2.50	0.56	28.9
Information Impact.....	1.95	2.50	0.55	28.2
TOTAL, Subactivity....	\$ 9.26	\$11.91	\$2.65	28.6%

The increase in the Information Science Program will continue an emphasis on research underlying advanced knowledge retrieval and manipulation systems. Additional emphasis will be placed on machine learning and adaptive information processing, and on problems of scaling up from theoretical to implemented systems. This takes the form of several awards at levels adequate for experimental testing of theory and the measurement of the performance of new programming techniques.

The Information Technology Program will maintain its focus on the augmentation of human performance of information tasks. It will expand the number of awards for experimental tests of human-machine interfaces and advanced systems for educational, decision-support, and computer programming applications.

The increase in the Information Impact Program will be to improve data resources for studies of the effects of information and computer technology in the workplace, and on industry structure and performance.

Support will be increased for research related to advanced computing, focusing on distributed and parallel information processes. Emphasis will be on discovering algorithms suitable for implementation on innovative distributed and parallel processing computers.

Support for instrumentation will increase throughout the Subactivity, chiefly for the provision of computer equipment and programming activity required for systems implementation and experimentation, but also for the development of databases for measuring economic and social effects of computing.

**ASTRONOMICAL, ATMOSPHERIC, EARTH,
AND OCEAN SCIENCES..... \$383,210,000**

SUMMARY OF REQUEST

The FY 1987 Budget Request for AAEO is \$383,210,000, an increase of \$20,613,032 or 5.7 percent over the FY 1986 Current Plan of \$362,596,968.

Program Subactivity	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Astronomical Sciences.....	\$82,764,118	\$88,670,000	\$84,220,000	\$85,060,000	\$840,000
Atmospheric Sciences.....	95,063,657	97,640,000	96,780,000	100,650,000	3,870,000
Earth Sciences.....	45,962,177	51,500,000	48,940,000	54,950,000	6,010,000
Ocean Sciences.....	121,275,492	125,580,000	124,134,968	133,660,000	9,525,032
Arctic Research.....	7,961,309	8,780,000	8,520,000	8,890,000	370,000
Total.....	\$353,026,753	\$372,170,000	\$362,596,968	\$383,210,000	\$20,613,032

NSF ROLE

The astronomical, atmospheric, earth, and ocean sciences are multidisciplinary, observational sciences. Their observational character means that they are highly dependent on instrumentation and observing platforms which can be defined in the broadest sense to include astronomical observatories, satellites, aircraft, ships, or submersibles; specific data collecting devices, such as radio receivers, charge-coupled detector arrays, seismic detectors, and doppler radars; and data storage and computational equipment for handling data and interpretations.

The Foundation provides significant support for research in all of the astronomical, atmospheric, earth, ocean, and polar sciences, although the magnitude of the NSF share varies, depending generally on the levels of funding for mission-oriented research provided by other Federal agencies. Funding is provided directly through project grants and support for research activities at national research centers, as well as through formal mechanisms such as inter-agency committees, and through mechanisms entailing support of instrumentation and facilities. Coordination with other agencies that support similar or complementary areas of research is carried out via mechanisms such as interagency agreements and standing committees, and through frequent staff contacts, joint participation in advisory and planning groups, and other joint meetings.

Astronomical Sciences. NSF is the lead agency for Federal support of ground-based astronomy. Since 1976, NSF has maintained a relatively constant role, providing about 65 percent of academic research support. The other principal sources of Federal support are the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD).

Continued activity in space astronomy—including the need for coordinated observations in different wavelength regions and the discoveries expected from such instruments as the NASA Space Telescope—will increase the demands on ground-based facilities.

Atmospheric Sciences. The NSF role in Atmospheric Sciences is to support research that will increase fundamental knowledge of the physics and chemistry of the atmosphere. NSF supports approximately 60 percent of the basic research conducted by universities in atmospheric sciences. The National Oceanic and Atmospheric Administration, the Department of Defense, the National Aeronautics and Space Administration, and the Department of the Interior also are major supporters of atmospheric sciences. These agencies fund research that is consistent with their respective missions. The knowledge gained through NSF support often provides the basis for mission-specific research. For that reason, much of the atmospheric science research support is collaborative with other agencies, particularly NASA and NOAA.

Earth Sciences. NSF currently provides about 75 percent of all Federal support for basic geological research in the Nation's universities. A renewed research interest in the structure and evolution of the continental crust provides the basis for a major emphasis on the earth sciences. This effort is driven, in part, by the need for increased understanding of plate tectonics; by the availability of improved techniques for deep crustal sensing; and by national requirements for better understanding of earthquakes and volcanoes, the location of strategic minerals and fossil fuel resources, and the effects of disposal of hazardous wastes. NSF supports primarily basic research in these areas in contrast to other major Federal funding sources—the U.S. Geological Survey, the National Aeronautics and Space Administration, and the Department of Energy—which support more applied research related to their missions.

Ocean Sciences. NSF and the Office of Naval Research are the principal supporters of basic ocean research. NSF provides about 70 percent of Federal funds for basic ocean research at U.S. academic institutions. Most of these funds are from NSF's Ocean Sciences subactivity.

The Foundation maintains a substantial research program in ocean sciences by supporting cost-effective shared use of ships and facilities by academic institutions and by focusing research support in areas having greatest potential for scientific return.

The NSF has a dual role in the Ocean Drilling Program. It supports directly the research activities of U.S. scientists participating in the program and provides the U.S. share of support for jointly sponsored operations and services. In addition, it is responsible for managing the program as an international enterprise and ensuring the financial and scientific participation of foreign partners in jointly sponsored scientific and operational elements.

Arctic Research. The NSF Arctic Research Program coordinates and extends U.S. research efforts in the Arctic. The Arctic Research and Policy Act of 1984 calls for the development and implementation of national policies and research plans and more extensive coordination of planning and budgeting by Federal agencies. Under the Act, NSF is designated lead agency for such activities and the NSF Director chairs the Interagency Arctic Research Policy Committee. Also, the Director is an ex-officio member of the Arctic Research Commission appointed by the President pursuant to the Act.

In recent years NSF has provided 15 to 20 percent of Federal arctic research support. The Arctic Research Program focuses on projects requiring special support such as the interdisciplinary and international Greenland ice sheet drilling and coring program, and major marine and terrestrial ecosystem studies of an interdisciplinary and multi-institutional nature.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Astronomical Sciences...	\$88.67	\$ 84.22	\$-4.45	-5.0%
Atmospheric Sciences....	97.64	96.78	-0.86	-0.8
Earth Sciences.....	51.50	48.94	-2.56	-5.0
Ocean Sciences.....	125.58	124.14	-1.44	-1.1
Arctic Research Program.	8.78	8.52	-0.26	-3.0
TOTAL, Activity.....	\$372.17	\$362.60	\$-9.57	-2.6%

The FY 1986 Current Plan is \$9,573,032 or 2.6 percent less than the FY 1986 Budget Request as summarized below. This change results from a Congressionally mandated reduction of \$2,500,000 for construction of the Very Long Baseline Array, a \$9,273,032 share of unspecified appropriation reductions, a transfer to AAEO from the STIA activity of \$1,200,000 for monsoon research under the U.S.-Indo Science and Technology Initiative, and a transfer from the Advanced Scientific Computing Activity to the Atmospheric Sciences subactivity to maintain support for the NCAR advanced computing system. The Ocean Drilling Program was not affected by the reduction.

The decrease in the FY 1986 Current plan from the Budget Request affects the AAEO subactivities most significantly in the areas of research project support and instrumentation development and procurement, and includes reducing the number of antennas purchased for the VLBA from three to two in FY 1986. Certain renovation and maintenance programs are deferred or stretched out. Particular facilities will be operated at somewhat diminished levels. Personnel impacts include salary freezes and reductions in staff.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Astronomical Sciences...	\$ 84.22	\$ 85.06	\$ 0.84	1.0%
Atmospheric Sciences....	96.78	100.65	3.87	4.0
Earth Sciences.....	48.94	54.95	6.01	12.3
Ocean Sciences.....	124.14	133.66	9.52	7.7
Arctic Research Program.	8.52	8.89	0.37	4.3
TOTAL, Activity.....	\$362.60	\$383.21	\$20.61	5.7%

The FY 1987 Request represents a 5.7 percent increase over FY 1986. The total AAEO increase of \$20,613,032 will augment ongoing base programs in each of the divisions and will contribute to NSF program emphasis in global geosciences, continental lithosphere studies, and computational science and engineering.

Within AAEO Global Geosciences represents a proposed activity increase for FY 1987 of \$16,280,000 to study the earth as an integrated global system. The activity is multidisciplinary, multiagency, and international in scope, and will integrate data from field programs, laboratory studies, and satellites. Implementation will take place through research efforts in the Atmospheric, Earth, and Ocean Sciences subactivities, and includes studies of global ocean and atmospheric circulation; biogeochemical fluxes and their relationship to climate variability; global tropospheric chemistry; and properties of the solid earth. Components of each of these activities are currently under way.

Astronomical Sciences are increased by \$840,000 for the support of university research, and for continued operations and some instrumentation at the National Astronomy Centers, including continued construction of the Very Long Baseline Array.

Atmospheric Sciences are increased by \$3,870,000 to augment project support, instrumentation and numerical modeling in the components of Global Geosciences dealing with global tropospheric chemistry and tropical climate. Additional support is provided for advanced scientific computing operations at the National Center for Atmospheric Research (NCAR), and for development of expanded computational capabilities in aeronomy, solar terrestrial research and meteorology.

Earth Sciences receives an increase of \$6,010,000, which is devoted to project support emphasizing studies of the continental lithosphere, and global and regional geologic studies related to the Global Geosciences effort. High priority will also be given to the development and acquisition of new instrumentation required for these advanced studies of the solid earth.

Ocean Sciences are increased by \$9,523,032. Incremental support will focus on global and interdisciplinary ocean studies which form the major components of the Global Geosciences thrust, including studies of global ocean circulation, heat flux, and climate. Other activities supported by this increase include the study of biogeochemical fluxes through the oceans, and planning for future studies of mid-ocean ridge crest processes.

Arctic Programs are increased by \$370,000 to augment the support for the Arctic Research Commission, and to provide for a greater emphasis on the applications of advanced computing to arctic research problems such as modeling of glacial motion.

CHANGES IN BUDGET STRUCTURE

Within the Arctic Research Program subactivity, the independent Arctic Research Commission now appears as a separate program element; support for the Interagency Arctic Research Policy Committee and its activities is included in the Arctic Research Projects program element.

ASTRONOMICAL SCIENCES \$85,060,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Astronomical Sciences is an increase of \$840,000 or 1.0 percent over the 1986 Current Plan of \$84,220,000.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Astronomy Project Support.....	\$27,234,351	\$28,560,000	\$27,610,000	\$27,700,000	\$90,000
National Astronomy and Ionosphere Center.....	6,050,000	6,350,000	6,150,000	6,100,000	(50,000)
National Optical Astronomy Observatories.....	22,826,767	24,050,000	23,800,000	24,200,000	400,000
National Radio Astronomy Observatory.....	26,653,000	29,710,000	26,660,000	27,060,000	400,000
Total.....	\$82,764,118	\$88,670,000	\$84,220,000	\$85,060,000	\$840,000

SCIENTIFIC OVERVIEW

Astronomy is the application of physics, chemistry, and mathematics to the entire universe beyond the earth. The objective of the Foundation's program in astronomical sciences is to increase our understanding of the physical nature of the universe, particularly that of the solar system, individual stars, star clusters, galaxies, and special objects such as molecular clouds and quasars. Advances in detector technology have made much of the spectrum accessible to ground-based observers. Studies in different portions of the spectrum, including those observable only from space, complement one another and are essential to understanding the many and varied objects and phenomena in the universe. Increasingly powerful instruments enable researchers to probe further out into space and further back into time in a quest to learn the origin, evolution, and fate of the universe and the celestial objects in it.

The Astronomy Survey Committee of the National Academy of Sciences studied the entire field of astronomy and recommended a coordinated, long-range program to NSF and NASA. Its report, Astronomy and Astrophysics for the 1980's, identified needs and priorities in ground- and space-based astronomy whose fulfillment would strengthen the Nation's efforts and maintain U.S. leadership in astronomy.

The subactivity supports ground-based astronomical sciences via research projects in all subfields, including instrumentation, and through the three National Astronomy Centers.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Astronomy Project				
Support.....	\$28.56	\$27.61	-\$0.95	-3.3%
National Astronomy and Ionosphere Center.....	6.35	6.15	- 0.20	-3.1
National Optical Astronomy Observatory.....	24.05	23.80	- 0.25	-1.0
National Radio Astronomy Observatory.....	29.71	26.66	- 3.05	-10.3
TOTAL, Subactivity....	\$88.67	\$84.22	-\$4.45	- 5.0%

Of the \$4,450,000 decrease between the FY 1986 Budget Request and the FY 1986 Current Plan, \$2,500,000 was required by Congressional action on the construction of the Very Long Baseline Array (VLBA). The remaining \$1,950,000 reduction resulted primarily from NSF's distribution of unspecified reductions in the FY 1986 appropriation.

The decrease of \$950,000 in Astronomy Project Support will require reductions in all programmatic areas, especially instrumentation.

The reduction of \$200,000 for the National Astronomy and Ionosphere Center (NAIC) will delay the start on new pulsar instrumentation and will require the deferral of renovation projects and some maintenance activities.

The reduction of \$250,000 for the National Optical Astronomy Observatories (NOAO) will slow down advanced technology development efforts and will require reductions in other programs.

The National Radio Astronomy Observatory (NRAO) is decreased by \$2,500,000 in funds available for construction of the Very Long Baseline Array (VLBA) and by \$550,000 from planned levels in research equipment, track maintenance, personnel, and in other operations at NRAO. Procurement of VLBA antennas in FY 1986 is expected to be reduced from the planned level of three antennas to two antennas. These will be equipped with receiving, data recording, and time keeping equipment. Procurement of most long lead and bulk purchase items for the VLBA will be deferred. At the FY 1986 level of effort, completion of the project will be delayed until 1994 and total project cost will increase to about \$81.5 million, (assuming four percent per year inflation).

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Astronomy Project Support.....	\$27.61	\$27.70	\$ 0.09	0.3%
National Astronomy and Ionosphere Center.....	6.15	6.10	-0.05	-0.8
National Optical Astronomy Observatories	23.80	24.20	0.40	1.7
National Radio Astronomy Observatory.....	26.66	27.06	0.40	1.5
TOTAL, Subactivity....	\$84.22	\$85.06	\$ 0.84	1.0%

The slight increase in Astronomy Project Support of \$90,000, to a total of \$27,700,000, is to support astronomical research in universities, particularly for instrumentation and the development of new detectors and observational capability. A unique submillimeter-wave antenna located in Hawaii will go into full operation. Support will be provided for the analysis of data obtained from observations of Comet Halley.

The net increase of \$750,000 for the National Astronomy Centers, to a total of \$57,360,000, will provide for their continued operation at a slightly reduced level, some additional instrumentation, and continued construction of the VLBA, planned at \$9,400,000 in FY 1987.

ASTRONOMY PROJECT SUPPORT

Background

Of the total requested for astronomical sciences, \$27,700,000 will be allocated to project support, an increase of \$90,000 or 0.3 percent more than FY 1986.

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Solar System Astronomy.....	\$1,249,957	\$1,300,000	\$1,250,000	\$1,250,000	\$0
Stars and Stellar Evolution.....	5,955,856	6,600,000	6,440,000	6,980,000	540,000
Galactic Astronomy.....	4,810,183	5,000,000	4,990,000	5,660,000	670,000
Extragalactic Astronomy.....	7,192,664	8,200,000	8,040,000	8,570,000	530,000
Astronomical Instrumentation and Development.....	7,925,691	7,360,000	6,790,000	5,140,000	(1,650,000)
Electromagnetic Spectrum Management...	100,000	100,000	100,000	100,000	0
Total.....	\$27,234,351	\$28,560,000	\$27,610,000	\$27,700,000	\$90,000

The project support to researchers covers all areas of ground-based astronomy, including research on the Sun, the solar system, the structure and evolution of the stars, stellar distances and motions, the composition and distribution of interstellar gas and dust, and the properties and motions of other galaxies. Support is also provided for the development and acquisition of new instrumentation incorporating the latest technology for the detection and analysis of radiation from astronomical sources.

Support for currently operating university radio observatories is provided by the Galactic Astronomy, Extragalactic Astronomy, and Stars and Stellar Evolution subelements. Development and major upgrades of university-based telescopes are supported through the Astronomical Instrumentation and Development subelement.

FY 1987 Budget Highlights

Specific areas that will be emphasized in FY 1987 include instrumentation and detectors, with particular emphasis on adapting charge-coupled device (CCD) array detectors to ground-based astronomical use. The use of array detectors sensitive to infrared wavelengths will also be supported. There will be enhancements to optical and millimeter-wave astronomy at university observatories. In radio astronomy, millimeter- and submillimeter-wave receivers will receive support. Full operation of a 10-meter antenna for exploration of the submillimeter-wave regions of the spectrum will take place in FY 1987.

The increases in the Stars and Stellar Evolution (STE), Extragalactic Astronomy (EXG), and Galactic Astronomy (GAL) subelements and the decrease in the Astronomical Instrumentation and Development (IDA) subelement reflect a partial transfer for support for the millimeter interferometers at the Owens Valley Radio Observatory, the Hat Creek Radio Observatory, and the California Institute of Technology Submillimeter-Wave Observatory. Support for these projects provided by the IDA subelement in FY 1986 will now be provided by the STE, EXG, and GAL subelements. These changes have been made since these instruments have shifted from a developmental to an operational phase.

NATIONAL ASTRONOMY AND IONOSPHERE CENTER

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Scientific Research Support.....	\$6,385,000	\$6,665,000	\$6,475,000	\$6,425,000	(\$50,000)
Less NASA Support.....	(335,000)	(315,000)	(325,000)	(325,000)	0
Total.....	\$6,050,000	\$6,350,000	\$6,150,000	\$6,100,000	(\$50,000)

Background

The National Astronomy and Ionosphere Center (NAIC) supports three areas of basic research: radio astronomy, radar astronomy, and the atmospheric sciences. The major research instrument at the NAIC Arecibo Observatory in Puerto Rico is a 305-meter diameter fixed reflector with a suspended feed platform. The latter provides a stage for the world's most sensitive and powerful radio/radar telescope. NAIC is operated by Cornell University from headquarters located on the university's campus in Ithaca, New York. The atmospheric sciences program is supported by funds budgeted under the Atmospheric Sciences subactivity.

During FY 1985, Arecibo Observatory was used by 147 visiting scientists from 50 U.S. and 21 foreign research and educational institutions. Of the total observing time available, about 72 percent was assigned to visitors. The total time allocated to radio astronomy programs was 75 percent; to radar astronomy, 6 percent; and to atmospheric sciences, 19 percent. This division of activities is typical of recent years; observing time allocations are based on scientific merit.

In FY 1985, the National Aeronautics and Space Administration reimbursed NAIC a total of \$238,023 for specific services performed in support of the International Cometary Explorer Mission.

FY 1987 Budget Highlights

The FY 1987 Budget Request for NAIC of \$6,100,000 provides for the continuation of observatory operations at a reduced level. The installation in FY 1987 of an experimental feed system for the 2 to 12 GHz range will enhance the observatory's capabilities for observations at these frequencies. A number of smaller projects and some user services will be curtailed.

NATIONAL OPTICAL ASTRONOMY OBSERVATORIES

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Scientific Research Support.....	\$22,883,767	\$24,068,000	\$23,983,000	\$24,400,000	\$417,000
Management Fee.....	378,000	417,000	417,000	430,000	13,000
Less ODO Support.....	(435,000)	(435,000)	(600,000)	(630,000)	(30,000)
Total	\$22,826,767	\$24,050,000	\$23,800,000	\$24,200,000	\$400,000

Background

The National Optical Astronomy Observatories (NOAO) operates an advanced development program, and the observing facilities of Kitt Peak National Observatory (KPNO), Cerro Tololo Inter-American Observatory (CTIO), and the National Solar Observatory (NSO). KPNO and CTIO provide U.S. astronomers with ground-based optical and infrared observing facilities required for advanced research in extragalactic, galactic, stellar, and planetary astronomy. The location of the observatories in both the northern and the southern hemispheres allows full sky coverage with forefront instruments. Solar facilities at Kitt Peak, Arizona, and Sacramento Peak, New Mexico, comprise the NSO.

During FY 1985, visiting scientists and students made more than 1,200 visits to the NOAO observatories to utilize the telescopes and data reduction and analysis facilities. Observing time on the telescopes is allocated on the basis of scientific merit.

KPNO is the largest center for ground-based astronomy available to U.S. researchers. Its nine optical telescopes are located on Kitt Peak, 90 kilometers southwest of Tucson, Arizona, and include the 4-meter Mayall Telescope, the Nation's second largest optical telescope (with a single objective mirror), and other technical, administrative, and public facilities.

CTIO is the only southern hemisphere observatory generally available to U.S. researchers. Seven optical and infrared telescopes are located on Cerro Tololo, a 2,194-meter peak on the Chilean slopes of the Andean cordillera, 65 kilometers inland from the coastal city of La Serena. The 4-meter telescope is the largest optical telescope in the southern hemisphere.

NSO provides unique instruments for high-resolution studies of the Sun. The Vacuum Tower Telescope at Sacramento Peak yields observations of the Sun throughout the year with higher angular resolution than any other ground-based telescope in the world. The McMath Solar Telescope, on Kitt Peak, the largest such instrument in the world, is used for high angular and spectral resolution studies of the solar surface. NSF funding of CTIO, KPNO, and NSO is:

	FY 1986 Current Plan	FY 1987 Estimate	Change	
			Amount	Percent
CTIO.....	\$5.15M	\$5.10M	\$-0.05M	-1.0%
KPNO.....	6.36M	6.30M	-0.06M	-1.0
NSO.....	\$3.51M	\$4.10M	\$+0.59M	+16.8%

NSF also supports a NOAO instrumentation development program and a variety of centralized offices and services.

Other Federal agencies reimbursed NOAO a total of \$629,000 in FY 1985 for specific services provided in support of their programs.

FY 1987 Budget Highlights

At the requested budget level of \$24,200,000, provision of access to telescopes, associated instrumentation, and computers for data processing and analysis will be provided to the scientific community at Cerro Tololo Inter-American Observatory, Kitt Peak National Observatory, and the National Solar Observatory. The remainder provides for other technical and centralized activities of the observatories. Technical and logistical support to users will be provided by NOAO staff but at a reduced level. Technology development applicable to future telescopes will continue at a constrained level. Work on global solar oscillations will be stressed.

NATIONAL RADIO ASTRONOMY OBSERVATORY

<i>Program Subelement</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Scientific Research Support.....	\$17,303,000	\$17,830,000	\$17,280,000	\$17,260,000	(\$20,000)
VLBA Construction.....	9,000,000	11,500,000	9,000,000	9,400,000	400,000
Management Fee.....	350,000	380,000	380,000	400,000	20,000
Total.....	\$26,653,000	\$29,710,000	\$26,660,000	\$27,060,000	\$400,000

Background

The National Radio Astronomy Observatory (NRAO) is one of the world's principal centers for radio astronomy, providing the U. S. scientific community with observational facilities necessary to carry out astronomical programs throughout the range of radio wavelengths. NRAO has its headquarters and a data processing center in Charlottesville, Virginia, but its telescopes are located at three other sites.

The two single-dish (91-meter and 43-meter) telescopes at Green Bank, West Virginia, are heavily used by observers. Observations can be made in the range from centimeter to meter wavelengths. The 43-meter telescope is often used in conjunction with radio telescopes in other locations for very long baseline interferometry.

The Very Large Array (VLA) near Socorro, New Mexico, provides a unique combination of high sensitivity and resolution for radio astronomy observations. Its 27 antennas are regularly used for mapping and spectroscopic observations. The latter give information on the composition and other properties of the objects observed.

The resurfaced 12-meter telescope, located on Kitt Peak, is used for observations at wavelengths as short as 1 millimeter.

In 1985, NRAO began construction of the Very Long Baseline Array (VLBA), consisting of ten 25-meter antennas to be located throughout the continental United States, Hawaii, and the U.S. Virgin Islands. The headquarters will be in Socorro, New Mexico. The VLBA will surpass all existing or planned telescopes in resolution, sensitivity, dynamic range, mapping capability, and frequency coverage. It will be complementary to the VLA as a unique instrument for probing in greater detail the heart of many of the most scientifically exciting astrophysical objects, through detailed examination of features unresolved by the VLA.

In FY 1985, other Federal agencies reimbursed NRAO a total of \$2,163,000 for specific services provided by the observatory in support of their missions.

FY 1987 Budget Highlights

The FY 1987 Budget Request for NRAO of \$27,060,000 provides for operation of the observatory on a somewhat reduced level, and for continuation of work on the VLBA.

In FY 1986, \$9,000,000 was provided for construction of the VLBA. Two antennas are to be procured and erected. Data-recording and time-keeping equipment and initial electronics components for these antennas will be acquired together with some longlead time items such as material for all antenna panels. In FY 1987, \$9,400,000 is planned for continuing construction of the VLBA at the FY 1986 level of effort. The funds will be used to procure two more antennas and their sites and to install receiving and recording equipment. Design work for the operations center and the correlating device will be resumed.

ATMOSPHERIC SCIENCES..... \$100,650,000**SUMMARY OF REQUEST**

The increase of \$3,870,000 requested for Atmospheric Sciences is a 4.0 percent increase over the FY 1986 Current Plan of \$96,780,000.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Atmospheric Sciences Project Support..	\$47,619,871	\$48,645,000	\$49,415,000	\$51,326,000	\$1,911,000
National Center for Atmospheric Research.....	43,503,056	44,906,000	43,135,000	45,191,000	2,056,000
Upper Atmospheric Research Facilities..	3,940,730	4,089,000	4,230,000	4,133,000	(97,000)
Total.....	\$95,063,657	\$97,640,000	\$96,780,000	\$100,650,000	\$3,870,000

SCIENTIFIC OVERVIEW

Atmospheric Sciences is a discipline in which knowledge of physics, chemistry, mathematics, and other sciences is combined in various ways to improve our understanding of the behavior of the earth's atmosphere, from the earth's surface to outer space. Studies of the motions, chemistry, and physics of the earth's atmosphere and its response to solar and terrestrial inputs are emphasized. This research is relevant to the national need of improved prediction and understanding of climate, weather, and the global environmental system and provides basic knowledge that can be used to support applications by mission agencies.

Atmospheric Sciences Project Support is provided over a wide range of subjects. By means of individual grants from the Atmospheric Sciences Project Support program element, scientists search for solutions to fundamental atmospheric problems.

The National Center for Atmospheric Research (NCAR) is the major research center in atmospheric sciences. It supports largescale atmospheric research projects including those requiring the use of aircraft and specialized instruments. NCAR cooperates with universities and with Federal agencies such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Aviation Administration (FAA). The principal users of NCAR's facilities are university and NCAR scientists.

The Upper Atmospheric Research Facilities program supports this Nation's four large incoherent-scatter radar facilities. These radars form a longitudinal chain from Greenland to Peru and allow scientists to investigate the local and global upper atmosphere.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Atmospheric Sciences				
Project Support.....	\$48.64	\$49.41	\$ 0.77	1.6%
National Center for				
Atmospheric Research...	44.91	43.14	-1.77	-4.1
Upper Atmospheric				
Facilities.....	4.09	4.23	0.14	3.4
TOTAL, Subactivity....	\$97.64	\$ 96.78	\$-0.86	-0.9%

There is a \$860,000 reduction in the FY 1986 Current Plan for Atmospheric Sciences from the Budget Request. This change is the net result of a \$2,460,000 share of the unspecified appropriations reduction, a transfer of \$600,000 from the STIA activity for the U.S.-Indo Science and Technology Initiative, and a transfer of \$1,000,000 from the Advanced Scientific Computing Activity for the NCAR advanced computing system.

The \$770,000 net increase for Atmospheric Sciences Project Support consists of a \$600,000 increase for the Presidentially mandated U.S.-Indo Science and Technology Initiative, a \$200,000 increase for the Genesis of Atlantic Lows Experiment (GALE), a field program to investigate U.S. East Coast winter storms, and a portion of the unspecified congressional reduction in the FY 1986 appropriation.

NCAR is decreased by \$1,770,000 below the FY 1986 Budget Request. Impacts caused by this reduction are: continuation of a freeze on all salaries (\$1,030,000); a reduction of 19 staff positions (\$590,000); and reduction of aircraft flight services by 11 percent (\$150,000).

Funding for Upper Atmosphere Facilities is increased by \$140,000 in order to replace capacitors leaking polychlorinated biphenyls at the National Astronomy and Ionosphere Center (NAIC) at Arecibo, Puerto Rico.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Atmospheric Sciences				
Project Support.....	\$49.41	\$51.33	\$1.91	3.9%
National Center for Atmospheric Research...	43.14	45.19	2.06	4.8
Upper Atmospheric Facilities.....	4.23	4.13	-0.97	- 2.3
TOTAL, Subactivity....	\$96.78	\$100.65	\$3.87	4.0%

The increase of \$1,910,000 in Atmospheric Sciences Project Support will be used primarily for the Global Tropospheric Chemistry, and the Tropical Oceans and Global Atmosphere components of the Global geosciences emphasis. At NCAR, the \$2,060,000 increase includes additional funds for the advanced computer system and the Global Tropospheric Chemistry Program. Funds for the Computational Science and Engineering emphasis are included in both the Project Support and NCAR requests. The decreases in support for the Upper Atmospheric Facilities will necessitate a slightly reduced level of operation.

ATMOSPHERIC SCIENCES PROJECT SUPPORT

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Aeronomy.....	\$6,469,039	\$6,701,000	\$6,521,000	\$6,583,000	\$62,000
Atmospheric Chemistry.....	7,101,438	7,249,000	7,289,000	9,201,000	1,912,000
Climate Dynamics.....	7,578,154	7,848,000	7,890,000	8,602,000	712,000
Experimental Meteorology.....	5,110,000	5,514,000	5,990,000	5,553,000	(437,000)
Global Atmospheric Research Program...	4,887,800	3,900,000	4,595,000	3,835,000	(760,000)
Meteorology.....	8,948,600	9,120,000	9,683,000	10,031,000	348,000
Solar Terrestrial Research.....	7,524,840	7,713,000	7,447,000	7,521,000	74,000
Total.....	\$47,619,871	\$48,645,000	\$49,415,000	\$51,326,000	\$1,911,000

Background

The objective of the Atmospheric Sciences Project Support program element is to expand fundamental knowledge of the atmospheres of the earth, other planets, and the sun. This includes understanding and improving our knowledge of:

- o The physical behavior of climate and weather;
- o The global cycles of gases and particles in the earth's atmosphere and the chemical and physical processes that control them;
- o The composition and dynamics of the upper atmosphere; and
- o The sun and neighboring planets as they relate to our understanding of the earth's upper atmosphere and space environment.

Support to achieve these objectives is provided to scientists from a broad range of disciplines through seven atmospheric sciences grant programs.

The Aeronomy Program supports theoretical, observational, and laboratory programs directed at understanding the upper atmosphere--its behavior, the physical processes determining that behavior, and the interactions of its constituents with solar electrons, protons, and electromagnetic radiations. Observational data are provided by various remote sensing instruments including optical and radar sensors.

The Atmospheric Chemistry Program supports modeling, laboratory, and field studies of natural and manmade trace gases and particles that influence the chemical composition and properties of the lower and middle atmosphere on the local, regional and global scale.

The Climate Dynamics Program seeks to improve understanding of global climate processes as a basis for predicting climate variations and for assessing their impact on human beings. To achieve such an understanding requires improved and expanded global observations of present climate variables and increased efforts to describe important physical processes that control climate. Improved climate prediction is a national effort that involves the activities of many government agencies.

The Experimental Meteorology Program supports field-oriented research on the physics and dynamics of the troposphere. Major areas of emphasis are cloud physics, weather modification, and mesoscale (storm-scale) precipitation systems.

The Global Atmospheric Research Program (GARP) supports research on fundamental questions: for example, how do various atmospheric and oceanic processes interact to change the state of the atmosphere? The program is designed to accomplish its objectives through a combination of analyses of observations collected during earlier field experiments, theoretical research, and numerical modeling.

The Meteorology Program supports basic research on various physical processes occurring primarily in the lower atmosphere. Current typical projects include atmospheric dynamics, turbulence, cloud and precipitation, physics, atmospheric electricity, radiation, synoptic and mesoscale meteorology, meteorological instrumentation, and computational facilities including interactive data processing.

The Solar Terrestrial Research Program examines four major areas: the sun, the interplanetary medium, the magnetosphere, and the upper atmosphere. A fifth research topic is that of the cosmic rays which pervade all these regions and are used as tracers to investigate solar terrestrial interactions as manifested by particles and fields.

FY 1987 Budget Highlights

The increase in atmospheric science project support in FY 1987 totalling \$1,911,000 will be used primarily for portions of the NSF Global Geosciences emphasis: to begin the Global Tropospheric Chemistry Program and to enhance the ongoing Tropical Oceans and Global Atmosphere (TOGA) project. Funds included here for the Computational Science and Engineering emphasis will be applied for continued development of interactive computational systems and for expanded computational capabilities in aeronomy, solar terrestrial research, and meteorology.

In FY 1987, the Global Atmospheric Research Program (GARP) will continue to be phased out with a decrease in funding of \$760,000. The decrease in Experimental Meteorology reflects a shifting of funds which were used to support the FY 1986 field activity in the Genesis of Atlantic Lows Experiment (GALE) to support of facility usage for the atmospheric research.

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Atmospheric Analysis and Prediction.....	\$3,578,000	\$3,727,000	\$3,487,000	\$3,766,000	\$279,000
Atmospheric Chemistry and Aeronomy.....	2,745,100	2,821,000	2,694,000	3,477,000	783,000
Convective Storms.....	2,426,300	2,486,000	2,302,000	2,351,000	49,000
Advanced Study Programs.....	1,405,600	1,445,000	1,348,000	1,543,000	195,000
High Altitude Observatory.....	3,529,600	3,613,000	3,388,000	3,390,000	2,000
Atmospheric Technology.....	7,268,900	7,454,000	7,157,000	7,346,000	189,000
Scientific Computing.....	11,485,800	11,821,000	12,965,000	13,819,000	854,000
Administration and Support Services.....	4,761,356	5,273,000	4,957,000	4,740,000	(217,000)
Physical Plant Operation and Maintenance.....	5,268,400	5,243,000	3,749,000	3,671,000	(78,000)
Contractor Fee.....	1,034,000	1,021,000	1,088,000	1,088,000	0
Total.....	\$43,503,056	\$46,806,000	\$43,135,000	\$45,191,000	\$2,056,000

Background

The National Center for Atmospheric Research (NCAR) is the major U.S. research center in atmospheric sciences. It carries out largescale atmospheric research projects including those requiring the use of aircraft and specialized instruments. NCAR cooperates with universities and with Federal agencies such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Aviation Administration (FAA). The dominant users of NCAR's facilities are university and NCAR scientists.

NCAR is managed and operated for NSF under a contract with the University Corporation for Atmospheric Research (UCAR), a nonprofit consortium of 54 academic institutions that offer doctoral programs in atmospheric science. Located in Boulder, Colorado, NCAR has a staff of about 748 of whom 30 percent are scientists and 70 percent are technical and support personnel.

Research at NCAR emphasizes increased understanding of atmospheric processes and events. The knowledge obtained is useful potentially for improved weather predictions, better severe storm forecasting, and improved understanding of changes in climate, changes in chemical constituents and modifies terrestrial weather and climate.

NCAR provides facilities for research in atmospheric sciences including powerful computing and data archival systems, a fleet of four NSF-owned research aircraft and radars and other instruments for observational and experimental programs. UCAR's policy is to charge full costs for use of NCAR facilities to all investigators--both NCAR and university--not receiving NSF support.

FY 1987 Budget Highlights

The Cray X-MP/48 advanced scientific computer is expected to be placed into operation at the start of the fiscal year. The new system will be utilized to enhance modeling and data analysis by the atmospheric and oceanographic communities. A plan for phasing out the Terabit Memory mass storage system through implementation of a hierarchical data storage system consisting of high capacity magnetic disks and tape cartridges will proceed. Funding will be increased from \$5,000,000 to \$6,500,000 to purchase computer hardware and to provide for full operational costs of the new system.

NCAR will participate actively in the Global Geosciences emphasis through the Global Tropospheric Chemistry Program. Development of instrumentation to measure tropospheric constituents will be accelerated and integrated with NCAR field facilities. Funding for these efforts is included in the Atmospheric Chemistry, Atmospheric Technology and Advanced Study Divisions at NCAR.

Advances in computational science and engineering, e.g., numerical modeling techniques, computer graphics, data analysis/assimilation, and algorithm development will be used in the study of atmospheric and oceanographic processes. The focus of this activity in FY 1987 will be on the earth climate system.

NCAR will provide aircraft, radar, and other field facility support to university and NCAR scientists at approximately the same level as in FY 1986. The Queen Air aircraft is not expected to be available due to damage sustained in FY 1986. Funding for repair or replacement of this aircraft is not included, but acquisition of a small twin engine aircraft is being investigated.

UPPER ATMOSPHERIC RESEARCH FACILITIES

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Upper Atmospheric Research Facilities....	\$3,940,739	\$4,089,000	\$4,230,000	\$4,133,000	(\$97,000)

Background

The Upper Atmospheric Research Facilities program provides continuing funding for four large incoherent-scatter radar facilities. These radars form a longitudinal chain from Greenland to Peru that allows scientists to investigate both the local and global upper atmosphere and to promote basic research on the structure and dynamics of the earth's upper atmosphere.

The radar chain includes: the Sondrestrom Radar Facility in Greenland operated by SRI International; Millstone Hill located near Boston, Massachusetts, operated by the Massachusetts Institute of Technology's Haystack Observatory; National Astronomy and Ionosphere Center (NAIC) located in Arecibo, Puerto Rico, operated by Cornell University; and Jicamarca Radio Observatory located at the magnetic equator in Jicamarca, Peru, operated by Cornell University. A High Frequency Heating Facility at NAIC also is supported.

To enhance scientific usefulness of the radar chain to the community, a data base is located at NCAR. The data base contains all the pertinent data collected by the radars in the chain, as well as data collected by other instruments including several European incoherent-scatter radars.

FY 1987 Budget Highlights

Since their alignment into a longitudinal chain (1982), the four incoherent-scatter radars supported by the Upper Atmospheric Facilities Program (UAF) have provided essential data to several studies of global-scale upper atmospheric processes. The emphasis in using the four radars in a coordinated manner to attack global-scale problems will continue. The requested funding will permit some improvements to the digital signal-processing systems. Other improvements regarding the upgrading and modernization of the aging receiving and transmitting systems will be postponed.

EARTH SCIENCES.....\$ 54,950,000

SUMMARY OF REQUEST

The increase of \$6,010,000 requested for Earth Sciences is 12.3 percent more than the FY 1986 Current Plan of \$48,940,000.

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Stratigraphy and Paleontology.....	\$3,849,000	\$3,800,000	\$3,800,000	\$4,000,000	\$200,000
Surficial Processes.....	2,925,434	2,900,000	2,900,000	3,300,000	400,000
Crustal Structure and Tectonics.....	3,900,000	3,900,000	3,900,000	4,100,000	200,000
Seismology.....	4,715,424	4,600,000	4,600,000	4,800,000	200,000
Experimental and Theoretical Geophysics..	4,954,899	4,900,000	4,900,000	5,200,000	300,000
Petrogenesis and Mineral Resources.....	4,049,499	4,000,000	4,000,000	4,300,000	300,000
Volcanology and Mantle Geochemistry.....	3,700,000	3,700,000	3,700,000	3,900,000	200,000
Experimental and Theoretical Geochemistry	6,011,451	6,000,000	6,000,000	6,100,000	100,000
Instrumentation and Facilities.....	6,693,327	6,300,000	5,000,000	5,000,000	0
Continental Lithosphere.....	7,163,143	11,400,000	10,140,000	14,250,000	4,110,000
Total.....	\$45,962,177	\$51,500,000	\$48,940,000	\$54,950,000	\$6,010,000

SCIENTIFIC OVERVIEW

Earth Sciences research provides the fundamental scientific basis for solving many of our most practical problems: the location and extraction of energy and mineral resources, the forecasting of earthquakes, volcanic eruptions and other natural events, and the potential consequences of activities such as dam construction or disposal of chemical or radioactive waste materials. Intellectual interest in the field is also high as the concepts of plate tectonics are applied to the study of the continents. Longstanding scientific questions such as the origins of mountain ranges, the growth of continents, and the causes of mass extinctions of life seem now on the verge of solution.

The Earth Sciences subactivity provides about 70 percent of the Federal support for basic research in the geological sciences at U.S. colleges and universities. Most of this support (about \$34 million in FY 1985) is in the form of individual research project grants awarded by the first eight of the Earth Sciences program elements. The Instrumentation and Facilities program is the principal source of support for the acquisition of research instrumentation by college and university geoscience departments. The Continental Lithosphere program supports larger scale coordinated projects that typically involve many different institutions.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Stratigraphy and				
Paleontology.....	\$3.80	\$3.80	\$ 0.00	0.0%
Surficial Processes.....	2.90	2.90	0.00	0.0
Crustal Structure and				
Tectonics.....	3.90	3.90	0.00	0.0
Seismology.....	4.60	4.60	0.00	0.0
Experimental and Theor-				
etical Geophysics.....	4.90	4.90	0.00	0.0
Petrogenesis and Mineral				
Resources.....	4.00	4.00	0.00	0.0
Volcanology and Mantle				
Geochemistry.....	3.70	3.70	0.00	0.0
Experimental and Theor-				
etical Geochemistry....	6.00	6.00	0.00	0.0
Instrumentation and				
Facilities.....	6.30	5.00	-1.30	-20.6
Continental Lithosphere.	11.40	10.14	-1.26	-11.1
TOTAL, Subactivity....	\$51.50	\$48.94	-\$2.56	-5.0%

The FY 1986 Budget Request did not include an increase for individual project support in Earth Sciences in order to concentrate the requested budget increase on two programs: Instrumentation and Facilities, and Continental Lithosphere. Further reduction of individual project support below the FY 1985 level would have adversely affected the ability of U.S. colleges and universities to maintain active programs in the geological sciences. Accordingly, individual project support programs were protected, and the unspecified reductions required by Congressional action were applied to the Instrumentation and Facilities and Continental Lithosphere program elements for which increases had been requested. The Instrumentation and Facilities element was reduced to \$5,000,000, which is 6.5 percent above the FY 1985 level. The Continental Lithosphere program was reduced to \$10,140,000, which permits development at a limited, but still viable, rate of seismic profiling activities, seismic arrays, a continental drilling program, and application of satellite geodesy to tectonic studies.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Stratigraphy and Paleontology.....	\$ 3.80	\$ 4.00	\$ 0.20	5.3%
Surficial Processes.....	2.90	3.30	0.40	13.8
Crustal Structure and Tectonics.....	3.90	4.10	0.20	5.1
Seismology.....	4.60	4.80	0.20	4.3
Experimental and Theoretical Geophysics.....	4.90	5.20	0.30	6.1
Petrogenesis and Mineral Resources.....	4.00	4.30	0.30	7.5
Volcanology and Mantle Geochemistry.....	3.70	3.90	0.20	5.4
Experimental and Theoretical Geochemistry....	6.00	6.10	0.10	1.7
Instrumentation and Facilities.....	5.00	5.00	0.00	0.0
Continental Lithosphere.	10.14	14.25	4.11	40.5
TOTAL, Subactivity....	\$48.94	\$54.95	\$ 6.01	12.3%

Background

The Earth Sciences subactivity has been emphasized by the Foundation for the last four years. This special emphasis derives from the following considerations: 1) the intellectual excitement and opportunity for major advances brought about by the application of plate tectonic theory to the study of the continental crust and lithosphere; 2) the availability of powerful new tools for the study of the deeper parts of the continents; and 3) the importance of fundamental knowledge about the earth as guidance in such areas of national concern as: energy and mineral resource development, forecasting and mitigation of natural hazards (such as earthquakes and volcanic eruptions), and the environmental impacts of human activities. Important sectors of the national economy--the petroleum and mineral resources industries--are heavily dependent upon both an improved knowledge of the earth and a supply of geologists and geophysicists. The FY 1987 Budget Request continues this emphasis in Earth Sciences.

Individual Project Support

These programs provide support for a wide range of geoscience subdisciplines and over a very wide spectrum of scientific problems ranging from the origin and evolution of life to the structure and composition of the earth's core. Earth Sciences-supported research is carried out on scales ranging from electron-microscope images of individual atoms in mineral crystals

to seismic oscillations in which the entire earth rings like a bell, and on time scales ranging from nanosecond shock impulses to the age of the earth itself. These research activities, as diverse as they are, are all directed toward an improved understanding of the earth--its composition and structure, the dynamic processes that shape its surface and interior, and the evolutionary history that brought it to its present state.

The FY 1987 Budget Request provides an increase of \$1,900,000 for individual project support programs. This increase is targeted at the following areas: global and regional geological studies related to the Global Geosciences emphasis; Earth Sciences participation in the Computational Science and Engineering emphasis; support of additional Presidential Young Investigators; and additional support for undergraduate research and education.

Instrumentation and Facilities

The Earth Sciences, like other fields of science, are dependent on instrumentation to provide accurate observations on many scales. Examples of instruments widely used by geoscientists include mass-spectrometers, electron-microprobes, x-ray and electron diffraction equipment, image-processing equipment, seismometers, cryogenic magnetometers and many more. Computers and computer peripherals are growing rapidly more powerful and more essential to front-line research. Some of the most promising lines of research require facilities (e.g., sources of synchrotron radiation or high-energy sources for mass-spectrometry) that are too costly to be supported by a single research project and must be shared by many investigators. The Instrumentation and Facilities program element seeks to provide earth scientists in U.S. universities and colleges with essential research instrumentation. A portion of these funds supports the development of new kinds of instruments or the adaptation of existing instruments for new uses in the geosciences. Funds requested for FY 1987 will permit continuing support for instrumentation at the FY 1986 level. High priority in FY 1987 will be given to image-processing instruments for use in global and large scale regional studies as part of the Global Geosciences emphasis.

Continental Lithosphere

This program element continues to be stressed. Continental Lithosphere supports several medium to large scale projects designed to bring important new tools and approaches into the hands of university-based earth scientists. These approaches, in combination, offer an opportunity to improve dramatically our understanding of the continental lithosphere--the outer rigid portion of the earth that underlies the continents and interacts with the deeper portions of the earth. This goal is the highest priority research goal for the earth sciences, for both scientific and practical reasons.

Activities supported under this program include:

Seismic Profiling (\$4.4 million) provides high resolution profiles of the continental crust, the upper part of the lithosphere. The petroleum industry spends \$4 billion annually applying the technique to shallow sedimentary basins. The NSF-funded COCORP and CALCRUST projects have shown that modified industry techniques can yield important discoveries about the deeper portions of the crust.

Seismic Arrays (\$4.7 million) consisting of many digital, wide-band, wide-dynamic-range seismographs linked to computers can provide high-resolution imaging of the crust and deeper parts of the lithosphere. Tomographic techniques (analogous to medical CAT scans) can be used to map the structure (and possibly the flow patterns) of the lithosphere and underlying

mantle. FY 1987 funds are requested to continue the addition of new and upgraded seismograph stations to the Global Seismic Network, to complete development and begin acquisition of portable seismic instrumentation, and to carry out data management and field experiments. These activities are closely coordinated with the U.S. Geological Survey and DARPA.

Continental Scientific Drilling (\$4.0 million) provides the calibration needed for geophysical sensing techniques such as seismic reflection profiling. Drillholes also provide the only way to obtain in-situ measurement of rock stress, pore fluid pressures, and other physical and chemical properties of deep-seated rocks. Samples are needed for isotopic and other laboratory studies. Funds are requested in FY 1987 to complete the Cajon Pass Scientific Drilling Project begun in FY 1986 in cooperation with the U.S. Geological Survey.

Satellite Applications (\$0.6 million) will use high-precision geodetic measurements to observe creep velocities along faults, swelling of volcanoes in response to magma movements, relative motions of lithospheric plates, and intraplate crustal deformations. Funds are requested for maintenance, operation and the first field testing of three Global Positioning System (GPS) receivers and associated instruments recently acquired for use by university geoscientists.

Physics and Chemistry of Geological Materials (\$0.5 million) will aid interpretation of geophysical observations by providing detailed knowledge of rock properties obtainable only through laboratory measurements. Use of geochemical tracers (isotopes and minor elements) can reveal the history of rock bodies.

These components of the Continental Lithosphere program are interdependent. Seismic methods are ambiguous without testing the subsurface directly by drilling--a fact well known to the petroleum industry. A drillhole is an extremely localized, one-dimensional sample that may be of limited value unless the features revealed can be extended horizontally using seismic techniques. A large portion of the information is lost without detailed laboratory studies of rocks and fluids. Tectonic processes that are currently active give insight into the ancient processes that shaped the lithosphere. All are dependent on a base of surface geologic mapping that has been slowly accumulating for many years. The Global Seismic Network and the GPS satellite applications are also important elements of the Global Geosciences emphasis.

OCEAN SCIENCES.....\$133,660,000**SUMMARY OF REQUEST**

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Ocean Sciences Research Support.....	\$58,330,932	\$59,940,000	\$59,956,000	\$66,438,000	\$-6,482,000
Oceanographic Centers and Facilities...	35,212,619	36,790,000	35,330,968	37,172,000	1,841,032
Ocean Drilling Program.....	27,731,941	28,850,000	28,850,000	30,050,000	1,200,000
Total.....	\$121,275,492	\$125,580,000	\$124,136,968	\$133,660,000	\$9,523,032

SCIENTIFIC OVERVIEW

The Ocean Sciences Program subactivity supports research to improve understanding of the sea, including the seafloor and the organisms in it and its relationship to human activities, through three program elements.

The **Ocean Sciences Research Support** program element supports research in all aspects of ocean sciences. Under this program, NSF seeks to improve our understanding of the factors controlling physical, chemical, geological, and biological processes in the ocean and at its boundaries (the air-sea interface, the seafloor, and the coastline). Increasingly, such understanding will come from newly developing global and interdisciplinary perspectives in which the ocean is viewed as a largescale, complex and interactive natural system and as one piece of the entire earth system.

The **Oceanographic Facilities Support** program element supports research ships and specialized shared-use facilities and equipment operated by U.S. academic oceanographic institutions. The objectives of this program are (1) to maintain and improve cooperative-use oceanographic ships and facilities in the academic community, (2) to promote shared use of major facilities, and (3) to ensure effective management of these oceanographic ships and facilities.

The **Ocean Drilling Program** supports research and operational aspects of the internationally supported Ocean Drilling Program. The program objective is to enhance our understanding of the composition and the processes affecting the submerged portion of the earth's crust. This understanding is essential to disciplines in earth, ocean, and atmospheric sciences and is being pursued using a large and newly outfitted drillship.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Ocean Sciences Research Support.....	\$ 59.94	\$ 59.96	\$.02	0.0%
Oceanographic Centers and Facilities.....	36.79	35.33	- 1.46	- 4.0%
Ocean Drilling Program..	28.85	28.85	0.00	0.0%
TOTAL, Subactivity....	\$125.58	\$124.14	-\$ 1.44	- 1.1%

The decrease of \$1,440,000 from the Budget Request is the net result of a transfer of \$600,000 from the STIA Activity for the U.S.-Indo Science and Technology Initiative, and the distribution of unspecified Congressional reductions, which were made so as to follow Congressional direction that the Ocean Drilling Program be maintained at a viable support level. Research and facilities support will maintain adequate activity support levels across the breadth of the field and will permit initial planning and developmental activities essential to future global and interdisciplinary initiatives. The budget reductions will result in modest decreases in the number of research projects and associated facilities operations.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Ocean Sciences Research Support.....	\$ 59.96	\$ 66.44	\$ 6.48	10.8%
Oceanographic Centers and Facilities.....	35.33	37.17	1.84	5.2%
Ocean Drilling Program..	28.85	30.05	1.20	4.2%
TOTAL, Subactivity....	\$124.14	\$133.66	\$9.52	7.7%

Ocean Sciences Research Support will expand support of initial work in global ocean studies started in FY 1986 to be a major component of the NSF Global Geosciences emphasis. Specific efforts will be made in the World Ocean Circulation Experiment, Tropical Oceans and Global Atmosphere studies, Global Ocean Flux Studies and Ridge Crest Studies. General disciplinary studies will be maintained at the FY 1986 support level.

Oceanographic Centers and Facilities will maintain support for the shared use of ships and facilities of academic institutions required to meet the needs of the science projects supported by the research support element. Support for the research submersible Alvin will be continued. Modest growth in support for the transfers and adaptation of new technologies for observations and data handling in ocean sciences will be supported.

Ocean Drilling Program support will be maintained at the FY 1986 level of effort. Increased international contributions from the addition of a sixth partner are anticipated to cover an existing shortfall for general operations of the drillship, support contractor, and publication requirements.

OCEAN SCIENCES RESEARCH SUPPORT

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Physical Oceanography.....	\$16,794,823	\$17,250,000	\$18,061,000	\$22,523,000	\$4,462,000
Chemical Oceanography.....	12,420,000	12,940,000	12,556,000	13,354,000	796,000
Marine Geology and Geophysics.....	15,232,282	15,700,000	15,360,000	16,144,000	784,000
Biological Oceanography.....	13,883,827	14,050,000	13,977,000	14,417,000	440,000
Total.....	\$58,330,932	\$59,940,000	\$59,956,000	\$66,438,000	\$6,482,000

Background

Ocean Sciences Research Support seeks to improve our understanding of the marine environment, how it behaves, and how human activities affect it. Research is aimed at determining how oceanic water masses form and move; how the ocean responds to the atmosphere; the ocean's influence on local weather conditions and on global climate; and the ocean's role in transporting and dispersing pollutants. Other research increases our knowledge of physical, chemical, and biological factors that regulate life in the sea and control the abundance and distribution of the ocean's living resources. Research is also extending our understanding of plate tectonics processes which provide a useful framework for earthquake prediction, and for oil and mineral resource exploration. Within NSF, some basic ocean research is supported by the Atmospheric Sciences, Earth Sciences, Biotic Systems and Resources, and Arctic Research sub-activities, and by the U.S. Antarctic Program.

Physical Oceanography supports research to understand the properties, motions, and boundaries of water masses and such driving forces as winds, solar radiation, precipitation, the earth's rotation, and tides.

Chemical Oceanography supports research on distributions of chemical elements and compounds in the ocean and in large lakes in order to understand the origin of various constituents, their distribution, how they are moved, how they are changed in transit, and how they affect and are influenced by organisms.

Marine Geology and Geophysics supports research to define the character and distribution of marine sediments and rocks, and to decipher such processes as plate tectonics, sediment transport, earthquakes, and submarine volcanism that control the nature of the seafloor.

Biological Oceanography supports research on marine life and its influence on biological productivity. Studies are supported on marine ecosystems, community/population dynamics, and organism ecology/physiology to improve our understanding of marine food webs and other complex organism relationships.

FY 1987 Budget Highlights

At the requested level all programs will maintain adequate but reduced research support across their disciplinary areas. Incremental support will focus on global and interdisciplinary ocean studies which form major components of the NSF Global Geosciences emphasis. These include:

- o major field programs in the equatorial Pacific and Indian Oceans and in the South Atlantic as a part of the Tropical Oceans and Global Atmosphere (TOGA) and World Ocean Circulation Experiment (WOCE) Programs;
- o development of field observational, satellite data processing, and numerical modeling capabilities for TOGA, WOCE, and Global Ocean Flux Studies; and
- o initial planning and development for a long term program to observe the temporal and spatial variability of mid-ocean ridge crest processes and the associated hydrothermal vent systems.

OCEANOGRAPHIC CENTERS AND FACILITIES

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Oceanographic Centers and Facilities...	\$35,212,619	\$36,790,000	\$35,330,968	\$37,172,000	\$1,841,032

Background

The Oceanographic Facilities Support program element supports scientific research at sea through ships and other shared-use facilities required by NSF grantees. This includes the operation and maintenance of research ships, the deep submergence research vehicle Alvin, salaries and expenses of marine technicians who maintain and operate shipboard scientific systems, the University-National Oceanographic Laboratory System Office, and other community coordinating activities. Support of surface ships in the academic fleet continues as the largest component. In FY 1986, NSF provided about 70 percent of the funds required to support operations of 20 of the 25 ships in the fleet. Support also comes from the Office of Naval Research, the U.S. Geological Survey, and from state government and private sources.

This program element also supports acquisition and development of modern instrumentation and equipment for shared use. The program emphasizes seagoing instrumentation and equipment used with research vessels or other facilities operated in support of ocean science research projects. Application of existing technologies to ocean sciences and development of new scientific instrumentation for broad usage by the community is also supported. Ship design studies and conversion and upgrading of ships and other platforms are included as required.

FY 1987 Budget Highlights

At the requested level of support, the program expects to continue to fund approximately 70 percent of research fleet operations by academic institutions and the NSF share of operations costs for Alvin. The number of seagoing projects is expected to remain essentially constant from FY 1986 to FY 1987. Normal cost growth for fleet operations, estimated at 4.2 percent, will require \$1,400,000 of additional funds.

Modest growth in the support of new technology and instrumentation is needed to implement the research projects included in the marine component of the Global Geosciences emphasis. Funding for marine technician and other supporting services will be maintained at existing levels of effort.

OCEAN DRILLING PROGRAM

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Ocean Drilling Program.....	835,339,131	\$41,350,000	\$41,350,000	\$45,050,000	\$3,700,000
Less Foreign Funding.....	(7,607,190)	(12,500,000)	(12,500,000)	(15,000,000)	(2,500,000)
Total.....	827,731,941	\$28,850,000	\$28,850,000	\$30,050,000	\$1,200,000

Background

The Ocean Drilling Program (ODP) supports studies of ocean basins, using ocean drilling to investigate oceanic crust and sedimentary deposits. The main thrusts are:

- o Increased understanding of the creation and destruction of the oceanic crust, motions of tectonic plates, and evolution of plate margins.
- o Detailed studies of the earth's climate and evolving life forms in relation to changes in oceans and atmosphere.

- o Improved understanding of processes controlling the formation and distribution of natural resources in the ocean floor.
- o Development of technology and instrumentation means for deep ocean scientific drilling and coring.

The Ocean Drilling Program builds upon the 15 years of achievements of the Deep Sea Drilling Project. The program supports improvements in technology and instrumentation required to perform more complex experiments.

Technological developments will include developing and deploying a system for drilling on bare rock without the sediment cover now required to stabilize the drill string. Such a system allows drilling on the newly formed crust at mid-ocean ridges, too young to have accumulated a sediment cover. These areas are sites of intense hydrothermal activity and mineral deposition. The drilling apparatus was successfully tested in November-December 1985.

In situ experiments will increase the scientific value of the holes themselves. Well logging tools routinely measure properties of rocks drilled including sound velocity, porosity, chemical composition, natural radioactivity, and state of stress. These observations are used to characterize those parts of the bore hole from which cores are not recovered and to connect the information gathered from the hole to regional geophysical and stratigraphic studies.

International members at present are France, Federal Republic of Germany, United Kingdom, Canada, and Japan. Negotiations are continuing with the European Science Foundation, representing a consortium of smaller European countries, and the USSR. An additional member is anticipated in FY 1987 from these two candidates.

FY 1987 Budget Highlights

The \$3,700,000 increase in the ocean drilling budget for FY 1987 is required to meet the costs of a fully operational program. Most of the increase will be met by expanded international contributions (\$2,500,000). NSF support will rise by 4.2 percent in FY 1987 to maintain the current level of effort by the United States.

The FY 1986 Budget Request was intended to support a full year of drilling operations and all associated logistics and scientific services. These items include ship and shore laboratories; core repositories and associated data banks containing samples and records; an engineering development program for drilling technology; and a center for the development and operation of down-hole logging instruments. All these activities are funded jointly by the United States and international partners. Cost experience in FY 1986 showed that budget requirements were underestimated and full support of science services to include publication costs were deferred to FY 1987. The contribution of a sixth international member will meet these requirements plus inflationary increases.

Each country participating in the Ocean Drilling Program independently supports the research related to the drilling program done by its own scientific community. The NSF Ocean Drilling Program will maintain support of drilling-related research activities of U.S. scientists, such as regional geophysical studies of potential drill sites, data synthesis, design of shipboard and down hole experiments, and workshops and symposia at the existing level of effort.

ARCTIC RESEARCH PROGRAM..... \$8,890,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for the Arctic Research Program is an increase of \$370,000 or 4.3 percent over the FY 1986 Current Plan.

Program Subelement	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Arctic Research Projects.....	\$7,711,309	\$8,480,000	\$8,220,000	\$8,390,000	\$170,000
Arctic Research Commission.....	250,000	300,000	300,000	500,000	200,000
Total.....	\$7,961,309	\$8,780,000	\$8,520,000	\$8,890,000	\$370,000

SCIENTIFIC OVERVIEW

The Arctic comprises the Arctic Ocean with the North Pole at its center, surrounded by partially ice- and snow-covered land masses, including areas of Alaska. Scientific interest spans the whole spectrum from the ocean bottom through the sea ice cover and out into space where the first interactions of solar radiation with the earth's atmosphere begin. It includes the arctic land areas and their plant and wildlife. The overall objectives are pursued through several program areas, including atmospheric, biological, earth and ocean sciences, glaciology, and information and advisory services. The general objective of the Arctic Research Program subactivity is increased knowledge of the arctic environment. The intended results are better prediction of arctic phenomena and a more intelligent extension of man's influence, especially in arctic regions of great practical importance to the United States.

In addition, in response to the Arctic Research and Policy Act of 1984, an interagency committee has been formed, chaired by the NSF Director. Its activities have resulted in an inter-agency five year program projection and a National Research Council Report on issues and research priorities. Further, the Arctic Research Commission provided for by the Act has been established, its members and staff appointed, and its activities are underway. An independent Federal body, it is funded through NSF as a matter of budgetary convenience. It is to provide policy recommendations to the Interagency Committee.

Research projects include over 80 grants each year that provide funds to an equivalent number of senior scientists and about 50 postdoctoral and graduate students. These scientists conduct projects in all the program areas listed. A similar amount of funding is provided from other budget subactivities, primarily in the AAEO Activity. In the case of project research support, coordination is carried out informally by program managers.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Arctic Research Projects	\$8.48	\$8.22	-\$0.26	-3.1%
Arctic Research Commission.....	0.30	0.30	0.00	0.0
TOTAL, Subactivity....	\$8.78	\$8.52	-\$0.26	-3.0%

The decrease from the request of \$260,000 is not of a magnitude to cause serious program disruption. Funding for the Arctic Research Commission is left intact.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Arctic Research Projects	\$8.22	\$8.39	\$0.17	2.1%
Arctic Research Commission.....	0.30	0.50	0.20	66.7
TOTAL, Subactivity....	\$8.52	\$8.89	\$0.37	4.3%

The FY 1987 Budget Request is \$370,000 or 4.3 percent above FY 1986. Of this increase, \$200,000, or 66.7 percent above its FY 1986 funding of \$300,000, is proposed for the Arctic Research Commission, an independent Federal Agency. The major additional efforts that the Commission plans are the establishment of an office in Alaska and an increase in international efforts relevant to arctic research policy. The remaining \$170,000 increase in Arctic Research Projects reflects a greater emphasis on the application of advanced computing techniques to arctic research problems in areas such as modeling of glacier and ice sheet activity.

The following table shows amounts requested for support of disciplinary research projects and Arctic Research and Policy Act activities.

DETAIL OF FY 1987 REQUEST

	<u>Disciplinary Research</u>	<u>Arctic Res. Policy Act</u>	<u>Total</u>
Arctic Research Projects	\$ 8.01	\$ 0.38	\$ 8.39
Arctic Research Commission	0.00	0.50	0.50
Total	\$ 8.01	\$ 0.88	\$ 8.89

CHANGES IN BUDGET STRUCTURE

In the Arctic Research Program subactivity, the Arctic Research Commission is now shown as a separate program element. It is an independent Federal body, but one for which funds will continue to be included in the NSF budget. NSF's own program activities under the Arctic Research and Policy Act of 1984 are included in Arctic Research Projects.

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS \$ 47,030,000

SUMMARY OF REQUEST

The FY 1987 Budget Request for Scientific, Technological, and International Affairs (STIA) is \$47.03 million, an increase of \$7.47 million, or 18.88 percent over the FY 1986 Current Plan of \$39.56 million.

Subjectivity	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Industrial Science and Technological Innovation.....	\$13,435,746	\$13,300,000	\$15,050,000	\$17,150,000	\$1,300,000
International Cooperative Scientific Activities.....	12,422,241	12,090,000	10,840,000	12,640,000	1,020,000
Policy Research and Analysis.....	5,146,170	1,990,000	1,940,000	1,990,000	50,000
Science Resources Studies.....	4,139,680	3,990,000	3,940,000	4,240,000	300,000
Research Initiation and Improvement.....	8,599,932	6,990,000	6,990,000	10,990,000	4,000,000
Total.....	\$43,743,769	\$38,360,000	\$39,560,000	\$47,030,000	\$7,470,000

NSF ROLE

STIA programs cut across scientific disciplines and link researchers in various sectors. Their purposes are to:

- o Provide opportunities for small, high-technology business firms to participate in NSF-supported research.
- o Develop cooperative international relationships and enhance the work of U.S. researchers by facilitating joint activities with foreign scientists and institutions.
- o Provide information and analysis for public policies designed to improve the Nation's scientific enterprise and its service to society.
- o Collect, analyze, and publish data on the status of the Nation's science and engineering resources.
- o Extend research opportunities for women, minority and handicapped researchers as well as faculty members from predominantly undergraduate institutions and other institutions which receive relatively little NSF funding.

The STIA activity meets needs not readily filled elsewhere in NSF or other Federal agencies. Efforts complement the mission-related responsibilities of technical agencies and the Department of State. Also, by making science resources data and staff-produced analyses available to the Executive Branch, the Congress, and the

public, STIA contributes to the quality of science and technology policy and to the long-term health of the S&T enterprise.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Industrial Science and and Technological Innovation.....	\$13.30	\$15.85	\$ 2.55	19.2%
International Cooper- ative Scientific Activities.....	12.09	10.84	- 1.25	-10.3
Policy Research and Analysis.....	1.99	1.94	- 0.05	- 2.5
Science Resources Studies.....	3.99	3.94	- 0.05	- 1.3
Research Initiation and Improvement.....	6.99	6.99	0.00	0.0
TOTAL, Activity.....	\$38.36	\$39.56	\$ 1.20	03.1%

The FY 1986 Current Plan for Scientific, Technological, and International Affairs of \$39,560,000 has increased by 3.1 percent, or \$1,200,000, above the FY 1986 Request. Four significant changes account for this difference:

- o The FY 1986 Budget Request of \$13,300,000 for the Small Business Innovation Research program was based on the figure of 1 percent of the Foundation's research budget. The Current Plan reflects a total program of \$15,650,000, equaling 1.25 percent of the NSF research budget, consistent with legislative requirements.
- o In the Industrial Science and Technological Innovation subactivity, \$200,000 is provided in the Current Plan for completing termination of Productivity Improvement Research by providing funds for prior year award commitments.
- o Resources amounting to \$1,200,000 were reallocated from International Cooperative Scientific Activities to the Foundation's disciplinary programs in the Atmospheric Sciences subactivity for support of monsoon research under the terms of the Indo-U.S. Science and Technology Initiative.
- o Adjustments of -\$50,000 each were made in three subactivities to reflect NSF's overall appropriation reduction. Those subactivities include International Cooperative Scientific Activities, Policy Research and Analysis, and Science Resources Studies.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Industrial Science and Technological Innovation.....	\$15.85	\$17.15	\$01.30	8.2%
International Cooper- ative Scientific Activities.....	10.84	12.66	01.82	16.8
Policy Research and Analysis.....	1.94	1.99	0.05	2.6
Science Resources Studies.....	3.94	4.24	0.30	7.6
Research Initiation and Improvement.....	6.99	10.99	4.00	57.2
TOTAL, Activity.....	\$39.56	\$47.03	\$ 7.47	18.9%

The FY 1987 Request for the Scientific, Technological and International Affairs Activity is \$7,470,000 more than the FY 1986 Current Plan of \$39,560,000. This increase of approximately 19 percent largely results from required growth in Small Business Innovation Research, the introduction of Minority Research Centers of Excellence, and inclusion of a full funding request for the Indo-U.S. Initiative in Science and Technology, where the Current Plan reflects partial reallocation to disciplinary programs. After adjusting for these significant changes, the increase in other core STIA programs amounts to growth of 1.9 percent, or a difference of \$470,000.

- o Industrial Science and Technology Innovation increases by \$1,300,000 (8.2 percent) for a total of \$17,150,000, dedicated entirely to the Foundation's Small Business Innovation Research Program. This level maintains the legislatively required 1.25 percent ratio to the NSF research budget.
- o International Cooperative Scientific Activities goes from \$10,840,000 in FY 1986 to \$12,660,000 in FY 1987. This requested increase of \$1,820,000 (16.8 percent) includes \$320,000 to expand U. S. participation in international cooperative research projects, seminars, and visits abroad with special emphasis on exchanges and enhanced collaborative research activities with countries of Western Europe and Japan. The remainder of the increase (\$1,500,000) reflects the fact that the entire \$2,000,000 requested for research under the terms of the Indo-U.S. Science and Technology Initiative is included in this subactivity in FY 1987. In the actual year of expenditure, some of these funds are reallocated to appropriate disciplinary programs according to bilaterally chosen fields.

- o Policy Research and Analysis increases slightly (2.6 percent) above its FY 1986 Current Plan for a total request in FY 1987 of \$1,990,000. Activities will include intramural analyses conducted by staff, and support of extramural research projects pertaining to issues of national interest.
- o Science Resources Studies goes from \$3,940,000 in FY 1986 to \$4,240,000 in FY 1987 with a net increase of \$300,000 (7.6 percent). This level maintains the science resources data base through continuation of the extensive science and engineering survey program while permitting additional emphasis on the state of U.S. academic research instrumentation and academic research facilities.
- o Research Initiation and Improvement begins a new program, Minority Research Centers of Excellence, with an increase of \$4,000,000 (57.2 percent), for a total request of \$10,990,000 in FY 1987. This Centers of Excellence program will provide incentives for a selected group of minority institutions to design and implement long-range plans to upgrade research and training capabilities in fields of science and engineering supported by NSF. Other subactivity programs, Visiting Professorships for Women and Research Improvement in Minority Institutions, are maintained at their FY 1986 levels.

CHANGES IN BUDGET STRUCTURE

Minority Research Centers of Excellence, a new program element in STIA, is added to the Research Initiation and Improvement subactivity. Four other program elements, formerly listed in this same subactivity, are now discussed separately under the Cross-Directorate Programs tab, created specifically to group and describe such Foundation-wide programs. These four programs are: Research Opportunities for Women, Minority Research Initiation, Experimental Program to Stimulate Competitive Research, and Support for Predominantly Undergraduate Institutions.

INDUSTRIAL SCIENCE AND TECHNOLOGICAL INNOVATION \$ 17,150,000

SUMMARY OF REQUEST

The FY 1987 Budget Request for Industrial Science and Technological Innovation (ISTI) is \$17.15 million, an increase of \$1.30 million, or 8.2 percent over the FY 1986 Current Plan of \$15.85 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Small Business Innovation Research.....	\$12,399,992	\$13,300,000	\$15,650,000	\$17,150,000	\$1,500,000
Productivity Improvement Research.....	1,035,754	0	200,000	0	-200,000
Total.....	\$13,435,746	\$13,300,000	\$15,850,000	\$17,150,000	\$1,300,000

SCIENTIFIC OVERVIEW

The Industrial Science and Technological Innovation subactivity provides opportunities for small science- and technology- based companies to perform research leading to more rapid commercialization of new products and processes.

The Small Business Innovation Research (SBIR) program element was developed by the National Science Foundation in 1977 to meet this role and the concept has since been incorporated into legislation (Small Business Innovation Development Act, P.L. 97-219) and expanded to include other agencies. The program is carried out in three phases: Phase I explores the feasibility of the proposed concept; Phase II is the principal research stage; and Phase III is the product development and commercialization stage, which is entirely supported by the private sector. The SBIR program in NSF places emphasis on the research phase and requires non-Federal venture capital funding in the latter technology development phase. As examples of recent SBIR program successes, two grantee companies became world leaders in their respective areas of genetics research, and each was able to attract over \$40 million in private sector support during Phase III.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN*(Millions of Dollars)*

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Small Business Innovation Research.....	\$13.30	\$15.65	\$02.35	17.7%
Productivity Improvement Research.....	0.00	0.20	0.20	---
TOTAL, Subactivity....	\$13.30	\$15.85	\$02.55	19.2%

The FY 1986 Current Plan of \$15,850,000 is \$2,550,000 more than the FY 1986 Request of \$13,300,000. The FY 1986 Request for SBIR was based on one percent of NSF's research budget, while the FY 1986 Current Plan reflects the 1.25 percent required by P.L. 97-219. Although Productivity Improvement Research has been terminated, \$200,000 in funding is required for the orderly phase-out of the program in FY 1986.

FY 1987 BUDGET HIGHLIGHTS*(Millions of Dollars)*

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Small Business Innovation Research.....	\$15.65	\$17.15	\$ 1.50	9.6%
Productivity Improvement Research.....	0.20	0.00	-0.20	-100.0
TOTAL, Subactivity....	\$15.85	\$17.15	\$ 1.30	8.2%

The SBIR Program will continue to support high quality research at science- and high-technology-based small business firms, where problems and opportunities could lead to significant public benefit if the research is successful. The increase of \$1,500,000 maintains the SBIR program at a level of 1.25 percent of the Foundation's research budget.

CHANGES IN BUDGET STRUCTURE

The Productivity Improvement Research program element is eliminated in FY 1987.

INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES..... \$ 12,660,000

SUMMARY OF REQUEST

The FY 1987 Budget Request for International Cooperative Scientific Activities is \$12.66 million, an increase of \$1.82 million, or 16.8 percent over the FY 1986 Current Plan of \$10.84 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
International Cooperative Science.....	\$11,116,055	\$11,390,000	\$10,140,000	\$11,960,000	\$1,820,000
International Scientific Organizations and Resources.....	1,305,386	700,000	700,000	700,000	0
Total	\$12,422,241	\$12,090,000	\$10,840,000	\$12,660,000	\$1,820,000

SCIENTIFIC OVERVIEW

This subactivity is responsible for supporting international cooperative programs that substantially benefit U.S. science and engineering. It also seeks to increase the access of U.S. scientists and engineers to unique research environments and facilities abroad, and coordinates NSF participation in cooperative scientific agreements with over 30 countries. Through this subactivity, the Foundation assists the Executive Office of the President and the Department of State in carrying out U.S. foreign policy. International Cooperative Scientific Activities provides the managerial focus for Foundation participation in international and multilateral organizations, e.g., the International Council of Scientific Unions (ICSU) and the International Institute of Applied Systems Analysis (IIASA), and for support of high priority Presidential S&T initiatives, such as those with India and China.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
International Cooper- ative Science.....	\$11.39	\$10.14	-\$01.25	-11.0%
International Scientific Organizations and Resources.....	0.70	0.70	0.00	0.0
TOTAL, Subactivity....	\$12.09	\$10.84	-\$ 1.25	-10.3%

The FY 1986 Current Plan reflects the reallocation of \$1.2 million in funds for the Indo-U.S. Science and Technology Initiative to the Atmospheric Sciences subactivity to support monsoon research. It also reflects a small adjustment (-\$50,000) in line with the general unspecified Congressional reduction.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
International Cooper- ative Science.....	\$10.14	\$11.96	\$01.82	17.9%
International Scientific Organizations and Resources.....	0.70	0.70	0.00	0.0
TOTAL, Subactivity....	\$10.84	\$12.66	\$ 1.82	16.8%

International competition in science and technology and its direct link to overall economic competitiveness has made it increasingly important to assure that U.S. scientists and engineers are aware of and have access to foreign scientific developments and centers of excellence abroad. This subactivity seeks to identify, design, and support the participation of the U.S. scientific and engineering community in cooperative activities that will best serve the interests of the Nation. To this end, it supports seminars, workshops, and research projects of high scientific merit. For example, through collaboration with Bulgaria, the

Illinois Institute of Technology has developed an enhanced method of oil recovery. The new technique also has significant implications in other fields such as food processing and pharmaceuticals.

- o The increase of \$1.82 million in International Cooperative Science includes \$320,000 for additional cooperative research activities with Western Europe and Japan, and will also provide additional funding for the Industrialized Countries Exchange program. This program was initiated in FY 1985 to increase opportunities for younger U.S. scientists and engineers to gain research experience and professional contacts in these countries.
- o The remaining increase is due to the fact that the entire \$2.00 million requested for NSF funding of the Indo-U.S. Science and Technology Initiative is included in this program element. During the actual year of expenditure, funds for research are transferred to appropriate disciplinary programs, according to current emphases of the Initiative. In addition to ongoing monsoon research, in FY 1987 a solid state science and engineering component of the Initiative will be fully operational, including a significant NSF-supported effort in minerals engineering.
- o The request for International Scientific Organizations and Resources includes funds for U.S. participation in selected multilateral scientific organizations, such as ICSU. (Discipline-specific activities of ICSU and IASA are funded by the relevant disciplinary subactivities.) Programs and activities of such organizations offer an increasingly important means of cost and resource sharing, as well as access to foreign scientific and technological developments.

POLICY RESEARCH AND ANALYSIS..... \$ 1,990,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Policy Research and Analysis (PRA) is \$1.99 million, an increase of \$0.05 million, or 2.6 percent over the FY 1986 Current Plan of \$1.94 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Policy Research and Analysis.....	\$5,146,170	\$1,990,000	\$1,940,000	\$1,990,000	\$50,000

SCIENTIFIC OVERVIEW

The Policy Research and Analysis subactivity provides NSF and other Executive Branch officials with analyses of specific national science and engineering policy issues. For example, in FY 1985 and 1986, the program analyzed issues related to geographic distribution of NSF funds, university facilities, scientist and engineer supply and demand, and undergraduate liberal arts colleges. Analyses are conducted by intramural staff, with contracted technical assistance for particularly intensive data gathering and processing tasks. In some cases, the program may support extramural research projects related to specific issues, e.g., methods for measuring contributions of basic research to achieving national goals and international comparisons of basic research programs.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Policy Research and Analysis.....	1.99	1.94	-0.05	-2.5%
TOTAL, Subactivity....	\$1.99	\$1.94	\$-0.05	-2.5%

The \$50,000 reduction in the Current Plan is due to an overall reduction in the Foundation's appropriation.

SCIENCE RESOURCES STUDIES..... \$ 4,240,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Science Resources Studies (SRS) is \$4.24 million, an increase of \$0.30 million, or 7.6 percent over the FY 1986 Current Plan of \$3.94 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Scientific and Technical Personnel.....	\$2,265,210	\$2,090,000	\$2,090,000	\$1,840,000	(\$250,000)
Funding of Science and Technology.....	982,791	1,300,000	1,250,000	1,700,000	450,000
Modeling and Special Science and Technology Indicators.....	891,679	600,000	600,000	700,000	100,000
Total.....	\$4,139,680	\$3,990,000	\$3,940,000	\$4,240,000	\$300,000

SCIENTIFIC OVERVIEW

The Science Resources Studies subactivity is the principal means by which NSF fulfills its mandate to "... provide a central clearinghouse for the collection, interpretation, and analysis of data on the availability of, and the current and projected need for, scientific and technical resources in the United States, and to provide a source of information for policy formulation by other agencies of the Federal Government..." Its efforts are divided between recurring studies and surveys, and special analyses and surveys needed for decisions on current science, engineering, and technology policy issues. Emphasis is placed on R&D funding, the supply and utilization of scientific, engineering, and technical personnel, and output and impact indicators.

The efforts supported by this subactivity generate the principal portion of all U.S. science, engineering, and technology resources statistics. The information fills a major need of science policymakers and R&D managers throughout the Nation and within the Federal government. Highest priority is given to the continued development and maintenance of an adequate quantitative information base. NSF maintains interagency agreements with agencies such as the Bureau of the Census, the Bureau of Labor Statistics, the Patent and Trademark Office, and the Office of Personnel Management. These agreements provide NSF continued access to the unique and comprehensive bodies of data collected and maintained by those agencies. In a number of instances these agencies carry out basic data collections for NSF as part of their large ongoing survey programs.

FY 1987 BUDGET HIGHLIGHTS*(Millions of Dollars)*

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Policy Research and Analysis.....	\$ 1.94	\$ 1.99	\$ 0.05	2.6%
TOTAL, Subactivity....	\$ 1.94	\$ 1.99	\$ 0.05	2.6%

A major study topic in FY 1987 will be the quality and quantity of the Nation's science and engineering graduates. By using available SRS data, combined with other types of information, PRA will attempt to determine if the temporary decline in potential science and engineering students due to low birth rates in the 1970's will cause a shortage of scientists and engineers in the nation, and what mitigating measures might be effective.

Another science policy issue of continuing relevance, for which studies will continue into FY 1987, is the role of scientific instruments in university research and education. It appears that research is becoming more capital-intensive, but such factors as increasing instrument capabilities, rapid technological obsolescence, dedicated versus shared equipment, variable maintenance costs, and rapidly changing capital costs severely confuse the issue. Improved understanding of instrumentation infrastructure issues will provide a better basis for NSF and Federal government instrumentation support programs.

results of the first and provide updated indicators of the stock, cost, condition, and utilization of major research instrumentation. Also to be supported is a survey of academic research facilities. This effort, again responsive to Congressional interest, will provide much needed quantitative indicators in an area of current concern and in which there is little reliable information currently available.

Changes in the individual program elements are:

- o Scientific and Technical Personnel will decrease by \$250,000 reflecting the cyclical nature of the regular surveys in the S&T Personnel Data System.
- o Funding of Science and Technology will increase by \$450,000 to fund surveys of academic research instrumentation and academic research facilities.
- o Modeling and Special S&T Indicators will increase by \$100,000. Emphasis will be placed on periodic studies and surveys required for the preparation of the Science Indicators reports; these activities will be at the peak of their biennial cycle during FY 1987.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Scientific and Technical Personnel.....	\$2.09	\$ 2.09	\$ 0.00	0.0%
Funding of Science and Technology.....	1.30	1.25	-0.05	-3.8
Modeling and Special Science and Technology Indicators.....	0.60	0.60	0.00	0.0
TOTAL, Subactivity....	\$3.99	\$ 3.94	\$-0.05	-1.3%

The FY 1986 Current Plan of \$3,940,000 is \$50,000 less than the FY 1986 Request, a reduction of 1.3 percent, due to overall reductions in the NSF appropriation. To accommodate this, the Funding of Science and Technology program element has been reduced by rescheduling a new sample used for the Survey of Industrial Research and Development.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Scientific and Technical Personnel.....	\$ 2.09	\$ 1.84	\$-0.25	-12.0%
Funding of Science and Technology.....	1.25	1.70	0.45	36.0
Modeling and Special Science and Technology Indicators.....	0.60	0.70	0.10	16.7
TOTAL, Subactivity....	\$ 3.94	\$ 4.24	\$ 0.30	7.6%

The FY 1987 Request represents a 7.6 percent increase over FY 1986. Since preserving the continuity of the existing science resources data base has highest priority, emphasis will be placed on maintaining the regular periodic surveys. The net increase will permit emphasis in two important areas by allowing support for the second cycle of a national survey of scientific instrumentation in academic institutions mandated by Public Law 96-44, Section 7. The first cycle of this survey was carried out in 1983-84. The second cycle will build upon

The program elements also respond to Presidential and legislative directives and requests, including Executive Order 12320, which expresses commitment to strengthening the capabilities of historically black colleges and universities, and the National Science Foundation Authorization and Science and Technology Equal Opportunities Act (P.L. 96-516), which expresses commitment to promoting the full development and use of the scientific talent and technical skills of men and women of all ethnic, racial, and economic backgrounds. These objectives are pursued through the following programs:

- o Visiting Professorships for Women provides support for women scientists and engineers to conduct research, teaching, and counseling activities as visiting professors at academic institutions.
- o Research Improvement in Minority Institutions improves the research environments at predominantly minority colleges and universities and other institutions with significant minority enrollments through the support of faculty research, research equipment, and cooperative research projects.
- o Minority Research Centers of Excellence provides support and incentives for a selected group of minority institutions to design and implement long-range plans to upgrade their research and training capabilities in fields supported by NSF.

This subactivity also has responsibility for coordinating the following programs, which are described under the Cross-Directorate Programs tab:

- o Research Opportunities for Women
- o Minority Research Initiation
- o Experimental Program to Stimulate Competitive Research
- o Support for Predominantly Undergraduate Institutions

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

No changes have occurred for the program elements supported by funds allocated directly to the Research Initiation and Improvement subactivity.

RESEARCH INITIATION AND IMPROVEMENT..... \$ 10,990,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Research Initiation and Improvement (RII) is \$10.99 million, increase of \$4.0 million, or 57.2 percent over the Current Plan of \$6.99 million.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Visiting Professorships for Women.....	\$2,142,524	\$2,000,000	\$2,000,000	\$2,000,000	\$0
Research Improvement in Minority Institutions.....	4,948,272	4,990,000	4,990,000	4,990,000	0
Intergovernmental Science and Technology.....	524,136	0	0	0	0
Ethics and Values in Science and Technology.....	985,000	0	0	0	0
Minority Research Centers of Excellence.....	0	0	0	4,000,000	4,000,000
Total.....	\$8,599,932	\$6,990,000	\$6,990,000	\$10,990,000	\$4,000,000

SCIENTIFIC OVERVIEW

The Research Initiation and Improvement subactivity supports research and related activities that strengthen the Nation's human and institutional resource base for science and engineering. Programs are conducted in coordination with and through the Foundation's discipline-oriented activities. The objectives of the subactivity are to:

- o Increase opportunities for women, minority and physically handicapped investigators and research faculty from predominantly undergraduate institutions to participate more fully in the Nation's scientific and engineering research enterprise;
- o Improve access to scientific and technical resources by institutions that currently underutilize such resources; and
- o Help identify and understand the human and institutional resources that contribute to the Nation's science and engineering needs, the barriers and problems that exist and the opportunities and solutions available, and to assist the Foundation in planning and managing NSF programs that address them.

ADVANCED SCIENTIFIC COMPUTING..... \$ 53,630,000**SUMMARY OF REQUEST**

ACTIVITY	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Advanced Scientific Computing.....	\$41,393,653	\$46,230,000	\$45,230,000	\$53,630,000	\$8,400,000

The FY 1987 Budget Request for Advanced Scientific Computing is \$53.63 million, an increase of \$8.40 million or 18.6% over the Current Plan of \$45.23 million.

SCIENTIFIC OVERVIEW

The Advanced Scientific Computing activity provides high quality access to unique advanced computational facilities for all segments of the science and engineering basic research community.

The specific objectives are:

- o To provide the large scale computational resources essential both to the research and to the training of scientists and engineers.
- o To extend and develop networks and communications systems which assure access to large scale computing facilities.
- o To create computer programs for making software more portable; making operating systems more user-friendly; providing more efficient programs for scientists; and developing means to handle, store and interpret massive amounts of data.

Supercomputers are powerful instruments; they have contributed and will continue to contribute significantly to the advancement of scientific and engineering research. Access to new computational centers for use in basic research activities will increase opportunities (1) for researchers to attack previously intractable problems through the development of complex numerical models; (2) for research communities to collect and analyze data leading to new insights concerning key scientific problems; and (3) for graduate students to obtain training in the use of supercomputers.

FY 1987 BUDGET HIGHLIGHTS

The following table includes only those program elements supported by funds allocated directly to the Research Initiation and Improvement subactivity:

(Dollars in Millions)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Visiting Professorships for Women.....	\$ 2.00	\$ 2.00	\$ 0.00	0.0%
Research Improvement in Minority Institutions..	4.99	4.99	0.00	0.0
Minority Research Centers of Excellence..	0.00	4.00	4.00	--
TOTAL, Subactivity....	\$ 6.99	\$10.99	\$ 4.00	57.2%

No change is requested for the Visiting Professorships for Women and Research Improvement in Minority Institutions program elements; both are operating effectively at current levels.

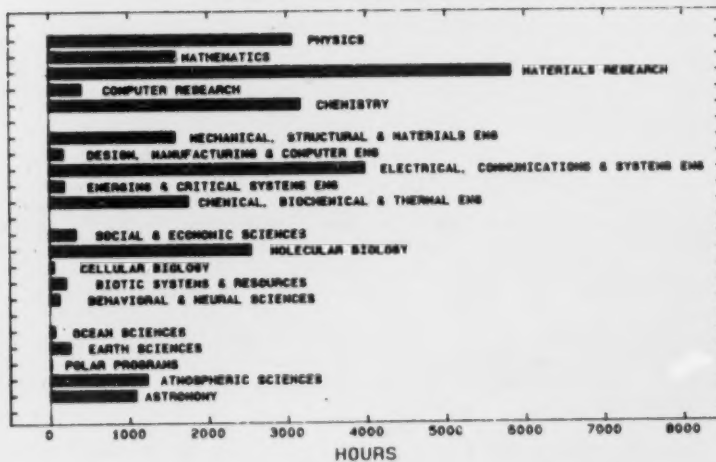
A new program element is proposed, Minority Research Centers of Excellence, for which \$4 million is requested. This program is intended to increase the quantity and strengthen the quality of NSF-supported research by drawing on an expanded pool of well-trained minority scientists and engineers. It is based on the premise that members of minority groups presently underrepresented in research will enter research careers if those careers are made more attractive and accessible. It would complement the awards made for Research Improvement in Minority Institutions, which support specific research projects, by encouraging a limited number of these institutions to undertake long-term efforts to develop into major centers for research and training.

The plan of Minority Research Centers of Excellence is to upgrade the research capabilities of the strongest and most productive minority institutions, and at the same time, enable these institutions to serve as resource centers for precollege, undergraduate and faculty training in other minority institutions in their areas. The program will be operated in two phases: (1) a planning phase, in which institutions will receive small awards to enable them to conduct self-assessments and develop plans to upgrade their research and training capabilities and (2) an implementation phase, in which the best institutional plans will be supported in amounts up to \$1 million per year for each of five years. Criteria for the implementation awards will include the extent to which the institution can demonstrate commitment of funds from its own and other non-Federal sources.

Effective development of supercomputer facilities requires the creation of a national scientific research network (NSFNET). Initially, points of access will be added to existing networks (ARPANET, BITNET, CSNET, MAILNET, MFENET) to provide access for NSF-supported researchers. At first, not all supercomputers will be directly accessible from all networks, but enough paths will be provided to assure effective access. Subsequently it will be necessary to try several experiments to provide information required for the development of NSFNET.

The challenge for NSF is to establish both centers and network access, to make efficient use of existing resources and capacities, and to create facilities dedicated to meeting the computational requirements of the many science and engineering disciplines. The time allocation chart which follows shows NSF experience to date in both the range and the degree of utilization among disciplines.

SUPERCOMPUTER ALLOCATION BY PROGRAM AUGUST 1984 - NOVEMBER 1985



NSF ROLE

NSF undertakings are consonant with similar activities undertaken or planned by other more mission-oriented Federal agencies, most notably the Department of Energy, Department of Defense, the National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration, which support research in weapons development, fusion energy, aerodynamics and atmospheric science. The NSF activity, as it provides advanced computing facilities to the academic basic research community, will make maximum use of the facilities and the knowledge of other Federal agencies.

The centers program focus is on providing large scale computational resources to all scientific and engineering disciplines for basic research requirements via national NSF supercomputer centers. NSF, with considerable supercomputer center experience, particularly in the atmospheric sciences, occupies a key position for creating this new science resource.

The approach of creating an Internet, or network of networks, will ensure connection of the national supercomputer centers and the more than 30 academic institutions of the two supercomputer center consortia with other users of the expanded ARPANET. Steps have been taken to design an interagency plan to interconnect existing individual agency networks. A Networking Working Group has been formed as part of the Federal Coordinating Committee on Science, Engineering, and Technology in order to provide coordination for this effort.

Through a new technologies effort NSF seeks to provide unique supercomputer hardware, and to facilitate engineers' and scientists' access to high powered machines via both user-friendly computer interfaces and improved software. NSF is especially capable of supporting such projects because of its commitments to scientific and engineering disciplines, to computer research, to mathematical development, and to the interface areas among these fields of science.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Activity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Advanced Scientific Computing.....	\$46.23	\$45.23	\$-1.00	-2.16%

A reduction of one million dollars from the FY 1986 Budget Request has been made in the centers program, and the funds reprogrammed to support development of an advanced supercomputer system at the National Center for Atmospheric Research.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Activity	FY 1986		Change	
	Current Plan	FY 1987 Request	Amount	Percent
Advanced Scientific Computing.....	\$45.23	\$53.63	\$ 8.40	18.57%

The requested increase will support significant growth of activities at the national centers, and a continuing level of effort in network and experimental technology development.

Background

The plan of the centers program has entailed a two phase approach: 1) to immediately provide time on supercomputers via lease agreements with existing supercomputing facilities, and 2) to replace the lease plan with new national centers. In FY 1985-86, NSF acquired services from six organizations to fill the immediate large scale computational needs of researchers. These centers are located at the University of Minnesota, Colorado State University, Purdue University, Boeing Computer Services, AT&T Bell Labs, and Digital Productions.

NSF is currently establishing three national supercomputer centers: the San Diego Supercomputer Center (University of California at San Diego, CRAY X-MP/48); the National Center for Supercomputing Applications (University of Illinois, CRAY X-MP/24); and the John Von Neumann Center for Scientific Computing (near Princeton University, CYBER 205 interim machine which will be replaced by an ETA 10). A fourth center, the Pittsburgh Center for Advanced Computing in Engineering and the Sciences, is in the process of initiation. In addition to providing supercomputer services to academic researchers, the national centers also encourage collaborative projects among visiting researchers.

During FY 1986 NSF has been working with the Department of Defense agencies, Department of Energy, NASA, and Department of Commerce to develop plans for NSFNET. This will build on the experience of DARPA with ARPANET, NSF with CSNET, and other government and private networks as well as the academic community's network, BITNET. A medium speed "backbone" network connecting the national centers was begun in 1986, ensuring that supercomputer users on campuses with ARPANET connections or members of consortia networks will be able to gain access to all NSF supercomputer centers.

In FY 1986 the experimental systems component of the new technologies effort has focused on a pilot program in interactive graphics and user-friendly, intelligent and transparent operating interfaces between keyboard and supercomputer. The program also has supported algorithm and software development. In addition, an experimental supercomputer center was

opened at Cornell University where access is provided to an advanced parallel system consisting of an IBM 3084 QX mainframe with a number of attached FPS 264 scientific processors. Parallel processing schemes effectively dissect complex mathematical problems into several independent calculations which can be performed concurrently rather than sequentially, thus providing considerable increases in performance.

FY 1987 Budget Highlights

The Phase I resource center activity will be continued at reduced funding levels. Phase II Centers (Illinois, Princeton, and San Diego) would be maintained at an augmented capabilities level and the John von Neumann Center will carry out the planned upgrade from a CYBER 205 to an ETA 10. The Pittsburgh Center will be undergoing rapid growth. Resource Centers will be supported only when they provide services not readily available at the national centers.

The NSFNET component of the networking program remains essentially the same as in FY 1986. This level of support allows the continuation of the commitments to the consortia networks, the community wide area networks (especially ARPANET), the NSF "backbone" network, and the existing networking pilot projects, plus limited support for network management and operations. No new networking projects will be begun. The local access component of the networking program will remain the same as in FY 1986, allowing funding of additional campus gateway systems so as to connect an additional 20-30 campuses to the ARPANET.

The new technologies program will upgrade the Cornell center's IBM 3084 to an IBM 3090 in order to provide more supercomputing power to the user. Software technology and training will be furnished to accommodate a larger cross section of scientists and engineers; workshops will be supported to introduce investigators to the unique capabilities afforded by the facility. The request also allows for the possible development of a large scale, massively parallel computer system.

This program will also continue to develop innovative software, numerical methods and graphical techniques to meet the needs of the scientific and engineering communities. Included are user-friendly and transparent interfaces between the user and the computer, transportable computer programs and efficient mathematical and computational methods.

The table which follows displays the funding aspects of these plans for FY 1987 and relates them to prior years.

(Millions of Dollars)

	Actual FY85	Plan FY86	Current Request FY87
<u>Centers</u>			
JVNC (Princeton)	8.30	8.00	11.50
San Diego	4.70	9.10	11.50
Illinois	5.00	7.00	8.50
Pittsburgh	0.00	2.00	4.00
Resource Centers	10.20	3.35	2.33
Total	28.20	29.45	37.83
<u>Networking</u>			
NSFNET	3.70	5.78	6.00
Local Access	2.20	1.00	1.00
Total	5.90	6.78	7.00
<u>New Technologies</u>			
Experimental Center/ Cornell	4.90	6.30	6.20
Experimental Systems	0.90	2.70	2.60
Total	5.80	9.00	8.80

PROGRAM DEVELOPMENT AND MANAGEMENT.....\$78,000,000

PROGRAM ACTIVITY SUMMARY

The Program Development and Management Activity (PD&M) increases by \$5.5 million to \$78.0 million or 7.6 percent above the 1986 Current Plan.

	Actual FY 1985	Budget Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
FUNDS:					
Personnel Compensation and Benefits	\$52,400,802	\$50,381,000	\$52,531,000	\$52,820,000	\$289,000
Other Operating Expenses	19,550,468	19,519,000	19,969,000	25,180,000	5,211,000
Total	\$71,951,270	\$69,900,000	\$72,500,000	\$78,000,000	\$5,500,000
FULL-TIME EQUIVALENT EMPLOYMENT:					
Full-Time Equivalent, Permanent	1,033	1,033	1,033	1,033	0
Full-Time Equivalent, Other	140	141	141	141	0
Total, Full-Time Equivalent Employment.	1,173	1,174	1,174	1,174	0

DESCRIPTION

The PD&M includes funds for staff salaries, rent, travel, and other operating expenses necessary for the effective and efficient operations and management of the NSF.

NSF is organized into six program directorates, an administration directorate, five staff offices reporting to the Office of the Director, and the National Science Board.

Four directorates support and manage research programs: Mathematical and Physical Sciences (MPS); Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO); Biological, Behavioral, and Social Sciences (BBS); and Engineering (ENG). The directorate for Science and Engineering Education (SEE) manages the Foundation's education programs.

The Scientific, Technological and International Affairs (STIA) directorate consolidates international science programs, science resources studies, science policy analysis, and small business innovation. It directly supports some of these activities and also has coordinating responsibilities for others that cut across and are funded in the Foundation's research programs.

The Administration (ADM) directorate manages the agency-wide administrative and support services.

The staff offices reporting to the Office of the Director (OD) are:

- o Advanced Scientific Computing
- o Budget, Audit, and Control
- o General Counsel
- o Information Systems
- o Legislative and Public Affairs

The National Science Board Office provides for the analytical support to the Board and coordinates its activities with staff throughout the Foundation. Additional staff support to the Board is provided by other Foundation staff on an *ad hoc* basis.

Two offices formerly reporting to the OD have been reassigned. The Office of Equal Opportunity (OEO) moved intact to the ADM directorate to augment the resources applied to EEO goals and coordinate programs with the Foundation's Division of Personnel and Management. The Small Business Research and Development Office has moved to the Industrial Science and Technological Innovation Division of STIA, which is responsible for management of the SBIR program.

ACHIEVEMENTS

We are continuing to make significant changes in the way we do business, changes which are improving the quality and quantity of our products and services while reducing the administrative or "paperwork" burden. We have delegated fiscal responsibilities for managing PD&M activities to an appropriate management level giving managers added flexibility to balance and optimize available resources.

The most significant progress stems from the continually expanding capability of automation and related technologies. We are rapidly moving into an automated environment that maximizes the reasonably priced yet powerful hardware and software that is commercially available.

We have accelerated our personal computer acquisition schedule so that by the end of 1986, almost 900 workstations will be in place. At the same time, we are establishing administrative support centers to effectively support groups of people rather than individuals, thus redistributing and smoothing the workload. As local area networks develop, and an electronic mail system established, users will be able to electronically communicate internally among administrative support centers, other personal computers and the central computing facility, as well as with external users accessible through established national/international networks.

We are continuing to improve existing administrative and programmatic systems such as financial accounting, reviewer, and Budget Line Item Program (BLIP) systems, and develop new systems such as the Decision Support, Budget Information System (DSBIS). The DSBIS, still in its early developmental stages, would provide capabilities to extract, retrieve and develop *ad hoc* budget information from several other major NSF data systems.

To reduce the paperwork burden we are now appointing proposal reviewers (panelists) by letter rather than through the personnel appointment process, as in the past. This change results in significant reductions in processing time, paperwork and timekeeping records. It also permits assigning the costs of their service to the appropriate programs for which the proposals are being reviewed.

Finally, we are continuing to contract out those administrative functions which can be done effectively and efficiently by the private sector. In FY 1986, mailroom services were added to this list which already includes warehousing, certain ADP activities, and health services.

STAFFING

FULL-TIME EQUIVALENT (FTE) EMPLOYMENT

	Actual FY 1985	Budget Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Mathematical and Physical Sciences.....	120	129	127	127	0
Engineering.....	88	105	115	115	0
Biological, Behavioral, and Social Sciences	157	157	157	157	0
Astronomical, Atmospheric, Earth, and Ocean Sciences.....	153	159	165	165	0
Scientific, Technological, and International Affairs.....	169	159	145	145	0
Science and Engineering Education.....	53	55	63	63	0
Staff Offices of the Director.....	184	176	175	175	0
Administration.....	236	220	215	215	0
Consultants.....	13	14	12	12	0
TOTAL.....	1,173	1,174	1,174	1,174	0

Changes in FY 1986 FTE Allocations

The changes between the FY 1986 Request and the FY 1986 Plan are consistent with our stated policy of shifting resources from non-research to research areas. We were able to make this shift faster than expected for two reasons: administrative support staff declined at a fast rate during the hiring freeze which was in effect during part of 1985, and subsequently were not replaced in many cases; and some STIA staff were reallocated to the research directorates.

The additional flexibility as a result of this shift permitted higher allocation levels to certain developing research areas such as ENG, SEE and the Office of Advanced Scientific Computing. Additional FTE's were also allocated to AAEO for increasing workload.

Comparison of FY 1986 and FY 1987 FTE

The FTE level will remain at 1,174. At this time no changes are projected in the directorate allocations, but we will review them later in FY 1986 to be sure that they accurately reflect needs and priorities.

CHANGES BETWEEN THE FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Dollars in Thousands)

	<u>FY 1986 Request</u>	<u>FY 1986 Plan</u>	<u>Difference</u>	
			<u>Amount</u>	<u>Percent</u>
Personnel Compensation & Benefits	\$50,381	\$52,531	\$2,150	4.3%
Travel	3,000	3,450	450	15.0%
Other Operating Expenses	16,519	16,519	0	0.0
Total	\$69,900	\$72,500	\$2,600	3.7%

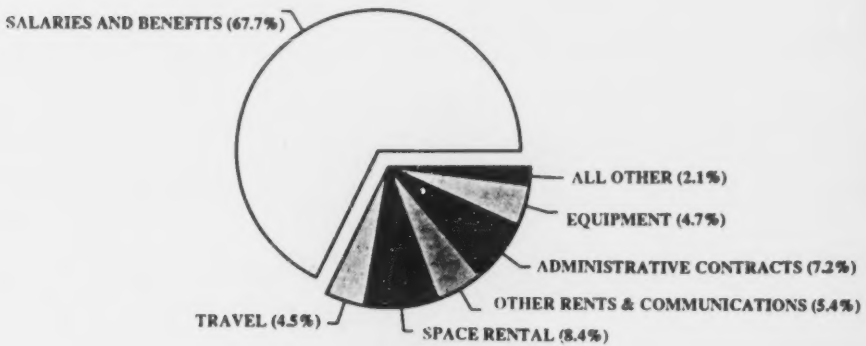
The changes between the 1986 Request and 1986 Plan may best be explained as follows:

1986 Request	\$ 69,900
Personnel Compensation:	
Restoration of Proposed 5% Pay Cut	\$1,843
Additional Funds	307

2,150	
Travel:	
Increase in limitation	450
1986 Plan	\$ 72,500

The additional funds -- \$307,000 -- are allocated to the personnel compensation and benefits to fund additional FTE's within the 1,174 limitation, and cover the potential liability for terminal leave stemming from retirements resulting from the proposed change in the tax law applicable to Federal employees' annuities.

The increase in the travel limitation -- \$450,000 -- has been allocated to directorate activities based on program requirements and 1985 spending levels. The 1985 actual levels are somewhat suppressed due to a proposed rescission of \$565,000 in travel funds pursuant to the Deficit Reduction Act, P.L. 98-369. This amount was withheld pending approval of the rescission. When the rescission was not approved, it was too late in FY 1985 to perform the postponed travel.

FY 1987 BUDGET HIGHLIGHTS**PROGRAM DEVELOPMENT AND MANAGEMENT
OBLIGATIONS BY MAJOR CATEGORY - FY 1987*****Personnel Compensation and Benefits***

	Actual FY 1985	Budget Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Personnel Compensation					
Full-Time Permanent.....	\$39,070,648	\$37,775,000	\$39,300,000	\$39,500,000	\$200,000
Other than Full-Time Permanent.....	5,978,323	5,720,000	6,040,000	6,040,000	0
Other Personnel Compensation.....	1,765,113	1,625,000	1,625,000	1,625,000	0
Proposal Reviewers, Panelists, and Advisors.....	469,557	600,000	500,000	500,000	0
Subtotal, Personnel Compensation.....	47,283,721	45,720,000	47,465,000	47,665,000	200,000
Personnel Benefits					
Employer Contributions: Retirement, Health Insurance, FICA, etc.....	5,093,004	4,620,800	5,005,800	5,094,800	89,000
Other Personnel Benefits.....	24,077	40,200	60,200	60,200	0
Subtotal, Personnel Benefits.....	5,117,081	4,661,000	5,066,000	5,155,000	89,000
TOTAL PERSONNEL COMPENSATION AND BENEFITS.	\$52,400,802	\$50,381,000	\$52,531,000	\$52,820,000	\$289,000

In FY 1987, personnel compensation and benefits are estimated at \$52,820,000 which is an increase of \$289,000 from the FY 1986 current plan of \$52,531,000. The increase will permit higher FTE utilization within the 1,174 limitation. Personnel benefits is increased by \$89,000 for the additional personnel compensation and for increase in the rates for the employer's contribution to FICA.

Travel

	Actual FY 1985	Budget Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
MPS: Staff.....	\$352,605	\$300,000	\$410,000	\$420,000	\$10,000
Reviewers, Panelists and Advisors....	95,643	160,000	120,000	120,000	0
Subtotal.....	448,248	460,000	530,000	540,000	10,000
ENG: Staff.....	232,193	280,000	330,000	340,000	10,000
Reviewers, Panelists and Advisors....	85,929	145,000	100,000	100,000	0
Subtotal.....	318,122	425,000	430,000	440,000	10,000
BBS: Staff.....	234,529	190,000	280,000	285,000	5,000
Reviewers, Panelists and Advisors....	96,221	315,000	290,000	290,000	0
Subtotal.....	517,153	505,000	570,000	575,000	5,000
AAED: Staff.....	415,722	379,000	480,000	490,000	10,000
Reviewers, Panelists and Advisors....	96,221	106,000	110,000	110,000	0
Subtotal.....	511,943	485,000	590,000	600,000	10,000
STIA: Staff.....	320,541	265,000	325,000	330,000	5,000
Reviewers, Panelists and Advisors....	70,927	60,000	70,000	70,000	0
Subtotal.....	391,468	325,000	395,000	400,000	5,000
SEE: Staff.....	73,207	85,000	115,000	125,000	10,000
Reviewers, Panelists and Advisors....	30,068	100,000	50,000	50,000	0
Subtotal.....	103,275	185,000	165,000	175,000	10,000
Staff Offices of the Director					
Staff.....	147,853	96,000	190,000	190,000	0
NSB & Advisors.....	258,222	300,000	290,000	290,000	0
Subtotal.....	406,075	386,000	480,000	480,000	0
Administration					
Staff.....	77,221	50,000	90,000	90,000	0
Advisors.....	8,036	10,000	10,000	10,000	0
Local Transportation.....	31,989	32,000	40,000	40,000	0
Rental of Passenger Vehicles.....	106,001	137,000	150,000	150,000	0
Subtotal.....	223,247	229,000	290,000	290,000	0
NSF Summary:					
Staff.....	1,853,871	1,635,000	2,220,000	2,270,000	50,000
NSB, Reviewers, Panelists, & Advisors	927,670	1,196,000	1,040,000	1,040,000	0
Local Transportation.....	31,989	32,000	40,000	40,000	0
Rental of Passenger Vehicles.....	106,001	137,000	150,000	150,000	0
TOTAL, TRAVEL.....	\$2,919,531	\$3,000,000	\$3,450,000	\$3,500,000	\$50,000

The limitation for travel in FY 1987 is raised to \$3.5 million, \$50,000 above the FY 1986 current plan. The distribution between directorates is consistent with FY 1986, with minor adjustments to accommodate program requirements such as engineering research centers, biotechnology, and geosciences.

OTHER OPERATING EXPENSES

	Actual FY 1985	Budget Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Transportation of Things	\$319,211	\$295,000	\$295,000	\$245,000	(\$50,000)
Rents and Communications					
Office Space Rentals	5,053,020	4,936,400	4,936,400	6,515,000	1,578,600
Data Processing Equipment Rentals	14,184	65,000	65,000	70,000	5,000
Other Rentals	54,720	47,700	65,000	65,000	17,300
Telephone, Telegraph and Communications	2,661,722	3,036,200	3,036,000	4,105,000	1,068,800
Subtotal, Rent and Communications	7,783,646	8,085,300	8,085,300	10,755,000	2,669,700
Printing and Reproduction.....	442,687	435,000	435,000	420,000	(15,000)
Other Contractual Services:					
Administrative Contracts.....	1,900,409	1,406,900	1,406,900	2,411,000	1,004,100
Audit Services.....	649,939	650,000	650,000	800,000	150,000
Data Processing Oper. & Maintenance...	891,090	765,000	765,000	1,250,000	485,000
Data Processing Software Development..	348,097	631,700	631,000	700,000	69,000
Employee Training	436,775	425,000	425,000	450,000	25,000
Subtotal, Other Contractual Serv.	4,226,310	3,877,900	3,877,900	5,611,000	1,733,100
Supplies and Materials:					
Office & Printing Supplies, etc.....	809,576	584,800	584,800	759,000	174,200
Data Processing Supplies	124,913	125,000	125,000	200,000	75,000
Subtotal, Supplies & Materials...	934,489	709,800	709,800	959,000	249,200
Equipment:					
Administrative Services Equipment.....	303,280	131,000	131,000	155,000	24,000
Data Processing Equipment.....	2,605,659	2,955,000	2,955,000	3,505,000	550,000
Subtotal, Equipment.....	2,908,939	3,086,000	3,086,000	3,660,000	574,000
Grants, Subsidies and Contributions					
Award Receipts.....	15,656	30,000	30,000	30,000	0
TOTAL, OTHER OPERATING EXPENSES	\$16,630,938	\$16,519,000	\$16,519,000	\$21,680,000	\$5,161,000

There are no changes between the budget request and the current plan for FY 1986.

Transportation of Things includes a \$10,000 increase in the cost of shipment of household goods and a \$35,000 increase in the cost of contract movers. These increases are offset by the transfer of funding for the warehouse and supply center, \$95,000, to Administrative Contracts. These activities have been contracted out to reduce operating costs.

An increase in the General Services Administration assessment for office space will require an additional \$1,354,900 for the Foundation. This represents a net increase in cost after a reduction of \$88,100 due to relinquishing all F Street space. Part of the net increase is also due to higher rates for reimbursable costs such as security and utility costs for maintaining the ADP center beyond the regular eight hour work schedule.

The increase of \$17,300 in Other Rentals is due to anticipated increases in rental cost for updating existing rented photocopy equipment.

Telephone, Telegraph, Cable, & Postage is increased by \$1,028,300 for telephone services, and includes the initial investment in a PBX System to provide improved communication services at a lower cost than the current system; by \$4,200 for rate increases for wire services of Western Union, ITT, and GSA; and by \$36,300 for a projected postal rate increase. This last increase is somewhat offset by our goal to decrease the volume of mail through greater use of electronic transmission.

Printing and Reproduction is decreased by \$15,000 as a result of NSF's effort to reduce paperwork and to continue to reduce printing costs by using in-house composition.

Administrative Contracts increases include funding for contracting out of Mail and Supply, Copy Room, and Warehouse/Supply activities, totaling \$430,000. The Health Services Facility has been fully contracted out and the annualized contract cost requires an increase of \$131,000. Maintenance costs for print plant and office equipment are increasing with the age of the equipment, although older equipment will be phased out as the use of personal computers increases. A small increase of \$25,000 is included for computer-oriented training.

Also included in this category are contracts for development of the DSBIS system (discussed under the Achievement section) and reimbursable audit services performed by other Federal Agencies (such as DHHS and Defense) and private accounting firms at institutions and at other grantees receiving NSF awards. Information Systems contracts will be explained under that section, below.

For Supplies and Materials, costs for journals and their distribution contract will increase \$50,000; printing and photocopy supply costs will increase \$25,000; and printing paper costs will increase \$26,000. The projected total of almost 900 computer workstations in place by the end of FY 1986 will require an additional \$73,000 for supporting supplies, including office furniture.

Equipment funds include \$4,000 for replacement of Health Services equipment and \$20,000 for science and engineering research and reference materials for the NSF library and staff.

Information Systems

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Budget Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Data Processing Rentals.....	\$14,184	\$65,000	\$65,000	\$70,000	\$5,000
Data Processing Contracts:					
Operations and Maintenance.....	\$91,090	\$65,000	\$65,000	1,250,000	485,000
Software Development.....	\$48,097	\$31,000	\$31,000	700,000	\$9,000
Data Processing Supplies.....	124,913	125,000	125,000	200,000	75,000
Data Processing Equipment.....	2,805,459	2,955,000	2,955,000	3,505,000	550,000
TOTAL.....	\$3,983,943	\$4,541,000	\$4,541,000	\$5,725,000	\$1,184,000

FY 1987 Highlights and Analysis

The FY 1986 current plan total is the same as the FY 1986 request.

Data Processing Equipment Rentals provide funds for the lease of hardware and software used in the NSF Computer Facility; state-of-the-art equipment which will be evaluated for its applicability to NSF functions; and leased timesharing support used in the development of prototype information systems.

Data Processing Operations and Maintenance cover:

- o Maintenance and repair services for all equipment in the NSF Computer Facility. This equipment includes the mail/network host installed in FY 1986, the network of three Hewlett-Packard (HP) minicomputers, associated peripheral hardware (such as the Xerox 9700 printing system), HP system software, and communications equipment needed to monitor and support HP operations.
- o Maintenance contracts for all other NSF-owned equipment, including microcomputers, terminals, printers, local area network components, and word processing equipment. At the end of FY 1985, over 1,000 micros, terminals, word processors, and portable terminals were covered by maintenance contracts. This equipment is used for decentralized processing of office-related applications and for the access of central NSF data bases, electronic mail systems, and external technical information systems.
- o The Facility Management Contract to operate the NSF Computer Facility on a 24-hour-a-day, seven-day-a-week basis. This contract covers such operator functions as tape handling, booking and binding of reports, computer monitoring, etc.

- o An Information Resources Center which provides NSF staff with: a) technical support and guidance in the use of automated systems; b) training in the application of ADP and office automation technology; and c) information and ADP resource sharing within NSF. The IRC combines in-house training resources with contractor support.

DP Operations and Maintenance will increase by \$485,000 to provide funds for the Information Resources Center (approximately \$250,000), to accommodate anticipated increases in the Facility Management Contract resulting from the addition of centrally-located equipment (approximately \$150,000), and to cover incremental increases in maintenance costs for the central computers and distributed workstations and to accommodate maintenance of the mail/network host installed in FY 1986 (approximately \$85,000).

Funding for the Information Resource Center is a high priority in FY 1987. By the end of FY 1986, it is anticipated that almost 900 workstations will be installed, with a commensurate need to support Foundation staff with adequate training and technical assistance.

Data Processing Software Development provides funds for contractor programming support in such areas as microcomputer applications, systems associated with the NSF budget cycle, data quality and maintenance projects, and developmental projects associated with new initiatives. The increase of \$69,000 reflected in the FY 1987 request is required to cover increased labor costs and provide for modest expansion of developmental efforts.

Data Processing Supplies funds are required to purchase all expendable supplies used in the NSF Computer Facility, including printer paper and ribbons, developer, dry ink, adhesives, magnetic tapes, labels, etc. Supply costs will increase by approximately \$75,000 due to the addition of equipment in the NSF Computer Facility.

Data Processing Equipment includes:

- o Central computer upgrade funds for the lease/purchase of a mainframe computer to support:
 - (1) a comprehensive and integrated decision support system providing a relational view of all agency data, complex data reduction operations, and sophisticated on-line data analysis;
 - (2) storage and retrieval of large textual files, including abstracts and the majority of Foundation-developed documents. The system will support interactive searching and extracting from several billion characters of text;
 - (3) interactive simultaneous access by many users;
 - (4) capability to support all NSF information requirements currently implemented on external systems (e.g., SRS data).
- o Workstation purchases for microcomputers, terminals, peripheral hardware (e.g., expansion boards, memory, printers, etc.), and micro software. By the end of FY 1985, approximately 625 personal computers had been purchased, and an additional 250 PCs are anticipated to be purchased in FY 1986. The expansion of the workstation network will phase out existing word processors and obsolete terminals.

- o Communications equipment purchases necessary to support on-line access to the central data bases and application systems. Purchases primarily include MICOM equipment and local area network components (including hard disks, boards, and software). The network front-end unit will be expanded to accommodate a rapid increase in workstation density and the expanding distributed processing environment. By the end of FY 1986, it is anticipated that all installed microcomputers can be connected to the central site and to each other via local area networks.

DP Equipment will increase by \$550,000, reflecting a substantial decrease in microcomputer equipment purchases and a substantial increase in central computer system upgrades. The \$3,505,000 request for FY 1987 will provide full funding for the purchase of 200 workstations and for communications and networking support for these units, as well as replacements and upgrades for previously purchased hardware and software. This purchase will increase the installed base of microcomputers to approximately 1,075. It will also fund the FY 1987 increment (approximately \$2,200,000) of the lease/purchase cost of the mainframe computer described above.

DETAIL OF PERMANENT POSITIONS

	FY 1985 Actual	FY 1986 Estimate	FY 1987 Estimate
Executive Level II	1	1	1
Executive Level III	1	1	1
Executive Level V	3	4	4
Subtotal	5	6	6
ES 6	9	9	9
ES 5	20	21	21
ES 4	45	52	52
ES 3	13	22	22
ES 2	7	9	9
ES 1	3	4	4
Subtotal	97	117	117
EE II	1	1	1
ES I	4	4	4
Subtotal	5	5	5
GS 15	210	210	210
GS 14	85	82	82
GS 13	70	72	72
GS 12	62	61	61
GS 11	45	45	45
GS 10	8	7	7
GS 9	59	60	60
GS 8	50	50	50
GS 7	107	97	97
GS 6	97	92	92
GS 5	58	55	55
GS 4	47	47	47
GS 3	17	18	18
GS 2	3	2	2
Subtotal	918	898	898
Ungraded	8	7	7
Total Permanent Positions	1,033	1,033	1,033

The table showing the detail of permanent positions is a summary of Permanent positions filled as of the end of FY 1985 and estimated to be filled at the end of FY 1986 and FY 1987. OMB Circular No. A-11 (Section 61.2) defines "permanent positions" as those which are occupied or to be occupied by full-time employees with permanent appointments."

PERSONNEL SUMMARY

	FY 1985 Actual	FY 1986 Estimate	FY 1987 Estimate
Total Permanent Positions.....	1,033	1,033	1,033
Total Compensable Workyears:			
Full-Time Equivalent Employment.....	1,173	1,174	1,174
FTE Overtime and Holiday Hours.....	7	7	7
Average ES Salary.....	\$67,860	\$69,700	\$69,700
Average GS Grade.....	10.07	10.30	10.03
Average GS Salary.....	\$39,236	\$40,859	\$40,900
Average Salary of Ungraded Positions...	\$22,868	\$26,000	\$26,000

The personnel summary shown above is based on the Detail of Permanent Positions Table.

U.S. ANTARCTIC PROGRAM..... \$117,000,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for the U.S. Antarctic Program is \$117.0 million, an increase of \$1.84 million or 1.6 percent over the FY 1986 Current Plan of \$115.16 million. This is a net increase after a \$14.4 million budget base transfer to the Coast Guard for icebreaker fixed costs.

<i>Subactivity</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
U.S. Antarctic Research Program.....	\$11,155,519	\$11,500,000	\$11,500,000	\$12,000,000	\$500,000
Operations Support.....	99,685,066	108,400,000	103,659,148	105,000,000	1,340,852
Total.....	\$110,840,585	\$120,100,000	\$115,159,148	\$117,000,000	\$1,840,852

SCIENTIFIC OVERVIEW

The U.S. Antarctic Program supports national goals to maintain the Antarctic Treaty, to ensure that the continent will continue to be used for peaceful purposes only, to foster cooperative research contributing to the solution of regional and worldwide problems, to protect the environment, and to ensure equitable and wise use of living and nonliving resources. The U.S. scientific research program continues to be the principal expression of national interest and policy in Antarctica.

The antarctic area is of further interest to the United States because it:

- o Has a major influence on world weather and climate;
- o Has the world's richest marine protein resource potential;
- o Has other resources of unique scientific and practical interest; and
- o Provides an excellent environment for international cooperation.

Antarctica is a unique location for the conduct of scientific research. It is a massive ice-covered continent surrounded by the waters of three oceans--Atlantic, Pacific, and Indian--with sea ice that advances and retreats hundreds of miles each year. This phenomenon along with the high elevation and extreme dry cold of the continent affects global atmospheric and oceanic systems. Living organisms, both marine and terrestrial, have adapted to the harsh environment in ways that are not well understood. The continent provides a stable research platform for long term observations of solar and stellar phenomena made possible by the continuous sunlight in the austral summer and the continuous darkness of the austral winter.

NSF ROLE

The National Science Foundation is charged by a Presidential Memorandum of February 5, 1982, with budgeting for and managing the U.S. Antarctic Program, including operations support, as a single package to maximize cost effectiveness and return on investment. United States policy calls for the maintenance of an active and influential presence in Antarctica. Scientific research is the principal expression of this presence which also includes:

- o Two coastal stations and one at the South Pole that are manned year-round. The coastal stations are McMurdo located on Ross Island at the edge of the Ross Ice Shelf and Palmer on Anvers Island adjacent to the Antarctic Peninsula. In addition, Siple, a fourth station at a remote location near the base of the peninsula, is operated as needed.
- o A logistic support system with a dedicated heavy airlift capability, support and staging bases at McMurdo and in New Zealand, and U.S. Coast Guard icebreaker support.

While the NSF has the responsibility for funding and managing the program, the Departments of Defense and Transportation provide, on a reimbursable basis, requested logistic and other operational support. The Foundation also employs a commercial contractor to maintain and operate South Pole, Palmer, and Siple Stations as well as a chartered research ship, Polar Duke. The Navy operates McMurdo Station, NSF LC-130 aircraft, and Navy helicopters.

In addition to the research program, the United States conducts other activities such as mapping and charting, weather observations, and ice forecasting. Representatives of U.S. Federal agencies, under guidance of the Department of State, conduct periodic inspections (provided for under Article VII of the Antarctic Treaty) of non-U.S. antarctic installations. (The U.S. is a consultative (voting) member of the Treaty). Many projects are performed by other Federal Agencies, with funding, management, facilities, and operational support provided by the National Science Foundation. Also, other Federal agencies may fund and undertake directed short-term programs of scientific activities subject to special review.

The Antarctic Policy Group, chaired by the Department of State, is responsible for providing policy guidance to the National Science Foundation regarding program content. The Polar Research Board of the National Academy of Sciences provides continuing advice on scientific opportunities and priorities.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Subactivity	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
U.S. Antarctic Research Program.....	\$ 11.50	\$ 11.50	\$ 0.00	0.0%
Operations Support	108.60	103.66	- 4.94	- 4.5
TOTAL, Activity.....	\$120.10	\$115.16	\$-4.94	-4.1%

There is a net reduction of \$4,940,832 or 4.5 percent in the Operations Support Program. This results from a \$5,000,000 reduction due to delay in a program for modernization and major rework of the two oldest LC-130 aircraft, a Navy responsibility. Also included in the Current Plan is an unobligated FY 1985 balance.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
U.S. Antarctic Research Program.....	\$11.50	\$12.00	\$0.50	4.3%
Operations Support.....	103.66	105.00	1.34	1.3
TOTAL, Activity.....	\$115.16	\$117.00	\$1.84	1.6%

The FY 1987 request is 1.6 percent above FY 1986. Plans are to increase support of research projects by \$500,000 from \$11,500,000, to \$12,000,000 or 4.3 percent. The 1.3 percent increase in Operations Support (\$1,340,832) from \$103,659,168 to \$105,000,000 is the net result of several major changes that are shown below:

(Dollars in millions)

o Budget base transfer to the Coast Guard for icebreaker fixed costs	\$-14.40
o Major maintenance and upgrading of LC-130 aircraft.	5.00
o Other equipment replacement and upgrading including <u>Polar Duke</u> equipment, electronics (e.g., for satellite communications, ground-based radars for aircraft operations), and civil engineering support equipment to replace machines that are over 20 years old.....	2.00
o First increment of McMurdo science lab construction to replace existing but obsolete labs.....	3.80
o Offset to increased operating costs including increased incremental cost of antarctic operation of icebreakers (about \$1.5M).....	4.94
Total.....	-\$1.34

U.S. ANTARCTIC RESEARCH PROGRAM..... \$ 12,000,000**SUMMARY OF REQUEST**

Support for the U.S. Antarctic Program is increased by \$0.5 million or 4.3 percent from \$11.5 million to \$12.0 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
U.S. Antarctic Research Program....	\$11,155,519	\$11,500,000	\$11,500,000	\$12,000,000	\$500,000

SCIENTIFIC OVERVIEW

The major objective of the U.S. Antarctic Research Program subactivity is to study the physical environment of Antarctica. Studies focus on the solid earth, the surrounding ice and oceans, the atmosphere, and the terrestrial and marine biota. In atmospheric sciences Antarctica forms a unique natural laboratory for investigating the upper atmosphere, high latitude and cold-related phenomena, meteorology, and solar dynamics. Ocean studies address the dynamics, paleontology, and marine ecology of the seas surrounding the continent. In the earth sciences studies address geology, geophysics, glaciology and plate tectonics. All of the scientific research efforts relate the Antarctic environmental processes to a global context.

Together, the studies in Antarctica improve our ability to evaluate antarctic renewable and nonrenewable resources and to facilitate sound management should they be significantly exploited under the terms of resource regimes negotiated by the nations party to the Antarctic Treaty. An additional important goal is international cooperation contributing to research objectives, to environmental protection, and to strengthening the Antarctic Treaty system.

The subactivity also funds curatorial centers for sorting and distributing ice cores, ocean sediment cores, and natural history specimens; scientific advice; publications which disseminate antarctic research information; and antarctic mapping by the U.S. Geological Survey.

During the average 120-day field season this subactivity supports about 320 scientists involved in some 100 discrete research efforts. Remote sensing techniques using satellites, aircraft, rockets, balloons, and unmanned stations are also employed in the conduct of the research. Cooperative research programs with scientists of other nations are commonplace.

In addition to the \$12,000,000 budgeted in FY 1987 for research through the U.S. Antarctic Research Program, the Operations Support Program contributes an additional \$16,100,000 in FY 1987 for research through the Direct Science Support program element. Hence, the total direct costs of research are well over twice the amount in the U. S. Antarctic Research Program subactivity, as shown in the following table.

(Dollars in Millions)

	<i>FY 1985 Estimate</i>	<i>FY 1986 Current Plan</i>	<i>FY 1987 Request</i>
Antarctic Research Support			
Antarctic Research Program.....	\$11.2	\$11.5	\$12.0
Direct Science Support (Operations Suppt. Prog.)..	14.0	15.3	16.1
Total..	\$25.2	\$26.8	\$28.1

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

<i>Program Element</i>	<i>FY 1986 Current Plan</i>	<i>FY 1987 Request</i>	<i>Change</i>	
			<i>Amount</i>	<i>Percent</i>
U.S. Antarctic Research.	\$11.50	\$12.00	\$0.50	4.3%

The total FY 1987 increase is \$500,000 or 4.3 percent from \$11,500,000 to \$12,000,000.

Specific research areas that will be emphasized in FY 1987 include:

- o Aerosols, trace gases, troposphere-stratosphere exchange processes, and major variations in the ozone shield over Antarctica.
- o The structure of the antarctic marine ecosystem and its relationship to the nutrient rich ice edge zone.
- o The geologic history, structure and tectonics of the Transantarctic Mountains and West Antarctica that relate both to resource and paleoclimate questions.
- o Increased studies of the dynamics of the West Antarctic ice sheet, and the clarification and extension of the climate record gained from ice drilling and coring.
- o The formation and flow of cold, nutrient-rich bottomwater phenomena that have implications both for marine ecosystems and weather and climate.

OPERATIONS SUPPORT PROGRAM..... \$ 105,000,000**SUMMARY OF REQUEST**

Support increases by \$1.34 million or 1.3 percent from \$103.66 million to \$105.0 million.

<i>Program Subelement</i>	<i>Actual FY 1965</i>	<i>Request FY 1966</i>	<i>Current Plan FY 1966</i>	<i>Estimate FY 1967</i>	<i>Difference FY 1967/66</i>
Direct Science Support.....	\$14,000,000	\$15,300,000	\$15,300,000	\$16,100,000	\$800,000
Base Level Support.....	\$7,600,000	70,000,000	70,059,168	59,700,000	(10,359,168)
Major Construction and Procurement..	19,085,066	23,300,000	18,300,000	29,200,000	10,900,000
Total.....	99,685,066	\$108,600,000	\$103,659,168	\$105,000,000	\$1,340,832

SCIENTIFIC OVERVIEW

This subactivity funds the facilities and services required for the conduct of antarctic research in the most cost effective manner consistent with safety, reliability, and the maintenance of an effective presence in Antarctica.

The location, climate and the absence of native population or development in Antarctica require importation of all forms of support and services needed to conduct research. The provision of such support and services is grouped, for central management purposes, in the Operations Support Program subactivity. Its elements are Direct Science Support, Base Level Support, and Major Construction and Procurement.

Direct Science Support includes estimates of those costs which directly support research, and which would not be incurred if the United States were merely to maintain a presence in Antarctica. This element supports operation of research ships and incremental costs of Coast Guard icebreaker operations. Also included are costs which most other NSF programs include as a part of research grants to the academic institutions. Examples are transportation to and from Antarctica, special personal clothing and equipment, aircraft support for research programs, field camp support, and laboratory and research equipment support.

Base Level Support provides the major continuing services that underpin the U.S. presence in Antarctica and make the science program possible. These services are provided on a reimbursable basis by the Departments of Defense and Transportation and by a contractor.

The U.S. Naval Support Force, Antarctica (NSFA) provides the primary logistic support for the U.S. Antarctic Program. This includes operation and maintenance at McMurdo Station, (the main staging point for most U.S. activities on the continent) and the year-round operation of Antarctic Development Squadron Six (VXE-6), which provides U.S. air support in Antarctica with seven NSF-owned ski-equipped LC-130 aircraft and six Navy UH-1H helicopters. Additionally, the NSFA is responsible for surface and air transport of cargo and personnel to New Zealand and Antarctica. The NSFA handles the charter of special mission C-141 that deliver most of the cargo and petroleum products used to support the U.S. program in Antarctica. The NSFA also provides communications to and within Antarctica and maintains a communications and staging base detachment in Christchurch, New Zealand, on a year-round basis.

Department of Transportation, through the U.S. Coast Guard, provides icebreaker support to the U.S. Antarctic Program. A channel is broken through the sea ice of McMurdo Sound each year and an icebreaker provides escort service for the cargo ships during their transit through the ice pack to McMurdo Station. A Polar class icebreaker also provides for the annual resupply of Palmer Station. Starting in FY 1987, only the incremental cost associated with antarctic operations of the icebreakers is funded by NSF.

The support contractor is responsible for the operation and maintenance of three research stations: South Pole, Siple (near the base of the Antarctic Peninsula), and Palmer (on an island off the Antarctic Peninsula); carries on major construction in Antarctica; and, provides some of the logistic and specialized support, such as operation and maintenance of the research ship, Polar Duke.

Major Construction and Procurement provides for the design, procurement, and construction of replacement facilities and of equipment needed for base level and direct science support activities. It also funds the procurement of major electronics, vehicles, and construction equipment and major repair or modifications to aircraft.

CHANGES BETWEEN FY 1986 REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Direct Science Support..	\$ 15.30	\$ 15.30	\$ 0.00	0.0%
Base Level Support.....	70.00	70.06	.06	0.0
Major Construction and Procurement.....	23.30	18.30	-5.00	-21.5
TOTAL, Activity.....	\$108.60	\$103.66	\$-4.94	-4.5%

There is a net reduction of \$4,940,832 or 4.5 percent in the Operations Support Program. This includes a \$5,000,000 reduction resulting from delays in activities to modernize and rework the two oldest LC-130 aircraft that are the responsibility of the Navy. Some of the long term work on the aircraft will take place FY 1986. The Current Plan also contains an unobligated FY 1985 balance of \$59,168, not in the Budget Request.

FY 1987 BUDGET HIGHLIGHTS
(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Direct Science Support..	\$15.30	\$ 16.1	\$ 0.80	5.2%
Base Level Support.....	70.06	59.7	-10.36	-14.8
Major Construction and Procurement.....	18.30	29.2	10.90	59.6
TOTAL, Subelement.....	\$103.66	\$105.0	\$ 1.34	1.3%

A budget base transfer to the Coast Guard to fund icebreaker fixed costs is offset by funding to upgrade the LC-130 fleet, to start a science laboratory at McMurdo Station, to meet equipment needs, and to provide for cost increases. Direct Science Support increases by \$800,000 from \$15,300,000 to \$16,100,000.

(Dollars in Millions)

	FY 1985 Estimate	FY 1986 Current Plan	FY 1987 Estimate
Contractor Support Equipment and Operations.....	\$ 5.9	\$ 5.9	\$ 6.6
<u>Polar Duke</u>	3.3	3.5	4.0
Icebreaker (Research Support)....	1.0	1.3	1.2
Ship Charter (Research).....	0.3	0.8	0.3
Aircraft Operations	2.0	2.3	2.3
Transportation of Science Personnel.....	0.7	0.7	0.8
Transportation of Scientific Cargo.....	0.6	0.6	0.7
Subsistence Costs for Civilian Personnel	0.2	0.2	0.2
Total.....	\$14.0	\$15.3	\$16.1

Contractor support equipment and operations provides for operation of South Pole, Palmer, and Siple (planned to resume in FY 1986) Stations on a year-round basis, and for at least one seasonal field camp at remote locations during the austral summer. Additionally, the contractor supplies and operates the Eklund Biological Laboratory and the Berg Field Center at McMurdo Station. It is through these two major facilities that most of the scientific field activities are supported.

An ice strengthened research ship, Polar Duke, operates during the austral summer in the Antarctic Peninsula area and elsewhere in the southern seas as needed. Icebreakers provide the special capability to operate in areas of heavy pack ice as needed by various research programs.

Ship charter costs are for occasional use of a ship from the academic fleet for work in the southern oceans, but not in the ice.

Aircraft operations are conducted using the LC-130s and UH-1Ns solely for science projects and through the short term lease of other aircraft for specialized science support.

Base Level Support decreases by \$10,359,168 from \$70,059,168 to \$59,700,000 (14.8 %). This figure is the net of provision for cost increases and the transfer of funding responsibility for icebreaker fixed costs back to the Coast Guard.

Estimates of Base Level Support

(Dollars in Millions)

	<i>FY 1985 Estimate</i>	<i>FY 1986 Current Plan</i>	<i>FY 1987 Estimate</i>
Personnel	\$ 27.5	\$ 28.3	\$ 29.2
Air Operations	14.8	15.2	15.4
Surface Transportation	2.8	3.3	3.5
Icebreaker Fixed Costs	13.8	13.9	-0- *
Icebreaker Incremental Costs.....	-	-	1.6
Antarctic Continent Operations ..	7.2	7.8	8.3
U.S. and New Zealand Operations .	1.5	1.6	1.7
Total.....	\$ 67.6	\$ 70.06	\$ 59.7

*Budget base transfer to the Coast Guard.

Personnel is the largest cost element in Base Level Support and includes more than 800 military personnel of the Naval Support Force, Antarctica, the Antarctic Development Squadron (VXE-6), and the civilians working under support contract.

Air operations include the cost of VXE-6 flight time and standard maintenance of the aircraft. Also included is the cost of additional chartered intercontinental airlift and of personnel transportation in connection with the Antarctic Program.

Surface transportation costs include the charter of a Military Sealift Command (MSC) cargo ship for the major resupply of McMurdo Station which, in turn, is the resupply base for operations in the interior of the continent.

Also included are the icebreaker costs for the escort service of the supply ships. Icebreaker costs starting in FY 1987 include only incremental costs associated with antarctic operations.

The Antarctic Continent Operations costs are those associated with maintaining a major base at McMurdo, adjacent air fields, and support of the three other stations: South Pole, Siple, and Palmer.

The Naval Support Force maintains a home base at the Naval Construction Battalion Center at Port Hueneme, California. The Antarctic Development Squadron has its home port at the Naval Air Station, Point Mugu, California.

Major Construction and Procurement increases by \$10,900,000 from \$18,300,000 to \$29,200,000 as follows:

(Dollars in Millions)

	<i>FY 1985 Estimate</i>	<i>FY 1986 Current Plan</i>	<i>FY 1987 Estimate</i>
Construction	\$ 8.2	\$ 9.0	\$13.0
Procurement			
Vehicular	3.9	2.2	3.2
General Purpose.....	6.0	7.1	13.0
Total	\$18.1	\$18.3	\$29.2

The Construction cost element reflects a continuing effort to restore or replace obsolete facilities, particularly at McMurdo Station, but also to a lesser degree at Palmer and Pole Stations. The salt water distillation plant at McMurdo is being completed and placed in full operation during FY 1986. The actual construction of the replacement building for the heavy equipment maintenance facility will commence in FY 1987. Engineering and design, for a new science laboratory, additional housing, and warehouse facilities for McMurdo Station, that commenced in FY 1985 will be continued. Purchase of prefabricated dormitory components has started. The major increase in FY 1987 construction will be to purchase modules of the science laboratory needed to replace the present hodge-podge of temporary and outmoded facilities.

General purpose and vehicular procurement allows for the replacement of obsolete and worn out equipment with new equipment such as large bulldozers, cranes, heavy shop equipment, and communications equipment, as well as ground based radars needed for air operations. General purpose funding also includes \$5,000,000 to upgrade the LC-130 aircraft fleet. In addition to work required on the two oldest aircraft, it is necessary to replace outdated, vacuum-tube electronic equipment in the five LC-130R models that were acquired in the mid-1970's. The Naval Air Rework Facility, Cherry Point, has prepared a multi-year plan for the upgrading of the LC-130 fleet. This plan has been endorsed by the Naval Air Systems Command and calls for somewhat increased funding in subsequent years.

SCIENCE AND ENGINEERING EDUCATION.....\$ 89,000,000**SUMMARY OF REQUEST**

The FY 1987 Budget Request for Science and Engineering Education (SEE) is \$89,000,000, an increase of \$1,955,675, or 2.2 per cent over the FY 1986 Current Plan of \$87,044,325.

<i>Subactivity</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
I. Research Career Development.....	\$27,297,922	\$27,300,000	\$27,344,325	\$27,300,000	-\$44,325
II. Materials Development, Research, and Informal Science Education.....	22,725,418	23,700,000	25,000,000	25,000,000	0
III. Teacher Preparation and Enhancement.....	25,188,387	24,000,000	27,000,000	27,000,000	0
IV. Studies and Program Assessment.....	1,747,713	2,000,000	2,200,000	2,200,000	0
V. College Science Instrumentation.....	4,996,379	5,000,000	5,500,000	7,500,000	2,000,000
Total.....	\$81,955,819	\$82,000,000	\$87,044,325	\$89,000,000	\$1,955,675

NSF ROLE

The responsibility of the Science and Engineering Education (SEE) Activity is to define and fund programs and projects that support the educational aspects of the Foundation's mission. The magnitude of the educational effort in the United States and the long lead times needed for new programs, materials and methods require a continuing and significant involvement in this area. Sustaining this level of commitment, visibility, and continuity expresses the serious national concern with science, mathematics, and engineering education and will draw the best, most creative people into the process.

SEE fulfills this responsibility by conducting leadership activities that inform and/or stimulate other sectors and by support of original work and other merit-based high-leverage activities that serve as prototypes and models of excellence for the Nation. A major objective is to encourage appropriate cooperation among academic scientists, engineers, educators and the private sector for intellectual partnerships as well as for leveraging funds.

The role of SEE is to help insure that:

- o a high-quality precollege education in science and mathematics is available to every child in the United States, sufficient to enable those who are interested and talented to pursue technical careers, especially in science and engineering, as well as to provide a base for understanding by all citizens.

- o those who select scientific and engineering careers have available the best possible professional education in their discipline. While other NSF programs provide apprenticeship training for the next generation of scientists and engineers through research support, SEE concentrates on the educational structure leading to this stage; that is, the teachers, students, laboratory, and classroom resources that remain important through under-graduate and graduate studies.
- o opportunities are available at the college level for interested non-specialists to broaden their science, mathematics and technology backgrounds. The great majority of students need a technical perspective and understanding to give them insights into and acquaintance with the principles, practices, techniques, and limits of science.
- o informal science education programs are available to maintain public awareness of and interest in scientific and technological developments that may affect their lives.

Particular attention is focused on the problems and strategy of assistance to precollege education--the area of greatest complexity and NSF's most urgent responsibility. The scope and complexity of the problems are so great and so diverse that we cannot expect wholly adequate or well-coordinated solutions to emerge spontaneously and totally from local, or even state institutions. Here, a Federal leadership role is particularly critical.

At the precollege level, NSF support is now targeted toward resolving problems of:

- o inadequate subject matter competence of current teachers;
- o inadequate subject area pre-service teacher preparation;
- o classroom materials that are outdated or poorly adapted to the needs of major populations;
- o ineffective use of advanced technology;
- o poor exchange of information about successful techniques and programs; and
- o insufficient opportunities for many talented young men and women to gain experiences that are critical to their early understanding and appreciation of science and mathematics.

A current major reflection of SEE's leadership role is the special emphasis on elementary and middle school levels of education. These are critical stages in the educational process and present problems of great magnitude.

In informal science education, NSF will continue, but not expand, support for "open-air" television broadcasts, and will increase support to help museums expand their role as a focus and locale for science clubs, hobby groups and other activities that encourage science interest.

At the undergraduate level, NSF has begun to attack the serious problem of deteriorating instrumentation in four-year colleges. Moreover, a special committee of the National Science Board is now completing an in-depth analysis of the problems facing undergraduate education and will recommend an appropriate NSF response.

NSF continues its diverse activities designed to ensure a continuing flow of the best and brightest students into careers in mathematics, science and engineering. This kind of activity has been a hallmark of NSF's role in science and engineering education and will continue to be prominent in its programs into the future.

SEE has a special role in the NSF with regard to increasing the participation of women, minorities and the physically disabled in science and engineering. Better educational opportunities and conditions at all levels are ways to success in this important area, and these are sought by SEE in all phases of its mission.

SEE coordinates its activities closely with other relevant areas of NSF and with other agencies, e.g. NASA, Department of Energy and the Department of Education (DoEd). Such coordination is intended to promote maximum use of expertise in the agencies, to minimize program overlap, and to optimize the use of limited Federal resources. NSF and DoEd, for example, have collaborated in supporting a number of projects, including the International Study of Mathematics and the broadcast series "3-2-1 Contact" and "The Voyage of the Mimi."

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

(Millions of Dollars)

Subactivity	FY 1986 Request*	FY 1986 Current Plan	Change	
			Amount	Percent
Research Career Development.....	\$27.30	\$27.34	\$ 0.04	0.2%
Teacher Preparation and Enhancement.....	25.00	27.00	2.00	8.0
Materials Development, Research, and Informal Science Education.....	22.70	25.00	2.30	10.1
College Science Instrumentation.....	05.00	5.50	0.50	10.0
Studies and Program Assessment.....	2.00	2.20	0.20	10.0
TOTAL, Activity.....	\$92.00	\$97.04	\$5.04	6.1%

* Includes \$31.45 FY 1985 Deferral plus \$50.55 in new obligational authority.

The SEE Activity received an appropriation of \$55,550,000 for its activities in FY 1986. This amount represents an increase of \$5,000,000 from the FY 1986 Budget Request of \$50,550,000. The FY 1985 carryover into FY 1986 was \$31,494,598 results from a planned deferral of \$31.45 million in the precollege areas and a small additional carryover of \$.04 million in the Research Career Development subactivity. The FY 1986 Current Plan totals \$87,044,325 and reflects the net effect of the FY 1985 deferral and carryover and the FY 1986 new obligational authority.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Subactivity	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Research Career Development.....	\$27.34	\$27.30	-\$ 0.04	- 0.2%
Teacher Preparation and Enhancement.....	27.00	27.00	0.00	0.0
Materials Development, Research, and Informal Science Education.....	25.00	25.00	0.00	0.0
College Science Instrumentation.....	5.50	7.50	2.00	36.4
Studies and Program Assessment.....	2.20	2.20	0.00	0.0
TOTAL, Activity.....	\$87.04	\$89.00	\$ 1.96	2.3%

The allocations for the Research Career Development; Materials Development, Research, and Informal Science Education; Teacher Preparation and Enhancement; and Studies and Program Assessment subactivities are unchanged from the FY 1986 Current Plan, enabling them only to maintain their base programs. However, this will include 560 new graduate fellowship awards in Research Career Development, and additional solicitations for proposals targeted at specific problems in science and mathematics in the Nation's elementary and secondary schools.

The FY 1987 SEE budget increase of \$2.0 million will be concentrated in the College Science Instrumentation subactivity, bringing it to a level of \$7.5 million. Because of the severity of needs in the undergraduate engineering disciplines, \$3.0 million will be targeted for strengthening the instructional engineering laboratories in the Nation's colleges and universities. The remaining \$4.5 million will be used to continue strengthening the laboratory instruction at four-year colleges as was done in FY 1985 and FY 1986.

CHANGES IN BUDGET STRUCTURE

For better compatibility and administrative efficiency, all precollege teacher program areas are now associated within one subactivity, and informal science education is now associated with materials development and research. Therefore, the former Materials Development and Research subactivity is now termed Materials Development, Research, and Informal Science Education, and the former Teacher Enhancement and Informal Science Education subactivity is now termed Teacher Preparation and Enhancement.

RESEARCH CAREER DEVELOPMENT \$ 27,300,000**SUMMARY OF REQUEST**

Support for Research Career Development is essentially maintained at \$27,300,000.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Research Career Development	\$27,297,922	\$27,300,000	\$27,344,325	\$27,500,000	- \$165,675

SCIENTIFIC OVERVIEW

Research Career Development promotes the career development of young scientists and engineers, and thereby helps to assure a steady flow of high-ability students through the educational and research training systems of the Nation. This objective is addressed through Graduate Research Fellowships, which promote the future strength of the Nation's scientific endeavors by recognizing and supporting the most promising graduate students. Highly talented U.S. citizens who are at or near the beginning of their graduate study are identified in a national competition. Awards for these portable fellowships are made on the basis of merit in all fields of science and engineering. Within this framework, support is also provided for graduate students who are members of ethnic minority groups under-represented in science and technology through the award of Minority Graduate Research Fellowships.

Fellowship awards provide both stipends and cost-of-education allowances (institutional allowances in lieu of tuition and fees). Up to three years of support is offered to outstanding graduate students for study at institutions of their choice. Full-time study support of this kind has historically accelerated Fellows' progress toward active and distinguished science and engineering careers. This support is made available in recognition of the importance of science and technology to the security and economic well-being of the Nation.

In FY 1987, Graduate Research Fellowships will constitute approximately 15 percent of the graduate student support provided by NSF, the balance being in the form of graduate research assistantships on NSF-supported research projects.

NSF Graduate and Minority Graduate Fellowships are among the most visible of NSF programs. The difficult national competition and the flexibility afforded Fellows under the terms of the program, and the career success records of former Fellows make NSF Fellows highly sought on the Nation's campuses. For example, in 1985 Dr. Jacqueline Barton, Assistant Professor of Chemistry at Columbia University, became the sixth former NSF Graduate Fellow to be awarded the Alan T. Waterman Award for young scientists in the forefront of their research field. The visibility of successful applicants exerts a strong influence on younger students contemplating careers in science and engineering. The selection of such outstanding Fellows in all fields of science and engineering also helps prepare the Nation in facing the research challenges of the next generation.

NSF Graduate Research Fellowships complement the graduate fellowship programs of several other Federal agencies. NSF is the only agency that provides this type of support across all science and engineering fields, a characteristic linked to the national recognition aspect of the awards. Other agencies target particular areas of science and engineering, a characteristic consistent with the more focussed missions of the agencies. Close and regular communication is maintained among the program staffs of NSF and other fellowship-granting agencies.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Research Career Development	\$27.30	\$27.34	\$.04	0.2%

Except for a minor carryover adjustment, the FY 1986 Current Plan is unchanged from the FY 1986 Budget Request.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Research Career Development	\$27.34	\$27.30	\$-0.04	-0.2%

In FY 1987, Research Career Development will continue the Graduate Fellowship Program at essentially the same level as FY 1986. Approximately 560 new awards will be offered to outstanding beginning graduate students in science and engineering. Including commitments from prior years, about 1500 students in total will receive such fellowship support. A minimum of 10% of the new awards will be made to minority students through a Minority Graduate Fellowship component.

These awards carry a 12-month stipend of \$11,100 and a cost-of-education allowance in lieu of tuition and fees to the fellowship institution of \$6,000. Each award may normally be renewed for a total tenure of three years.

MATERIALS DEVELOPMENT, RESEARCH, AND INFORMAL SCIENCE EDUCATION \$25,000,000

SUMMARY OF REQUEST

This subactivity is maintained at the FY 1986 level of \$25.0 million.

<i>Program Element</i>	<i>Actual FY 1985</i>	<i>Request FY 1986</i>	<i>Current Plan FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Materials Development, Research, and Informal Science Education	\$22,725,418	\$25,700,000	\$25,000,000	\$25,000,000	\$0

SCIENTIFIC OVERVIEW

This subactivity seeks to improve the quality of education and learning about mathematics, science and technology-- through a combination of improved materials, methods and tools, and a rich environment for informal learning outside the school. Current efforts are particularly focused on the needs and problems of early education for the great mainstream of average students.

It is typical that such students enter school with little background, but great enthusiasm for experimenting, exploring and learning about science. It is also typical that by the time they reach high school, where they first encounter formal studies like biology, chemistry and physics, most students have acquired little added experience in science or problem-solving and have come to regard these topics as difficult, dull and to-be-avoided whenever possible.

The subactivity addresses these problems directly by helping to encourage early experience and enthusiasm through such means as television and museums, and by supporting the development of improved new materials that can help schools to introduce science concepts and mathematical problem-solving in the earliest years. Efforts are particularly focused on forming cost-sharing partnerships with publishers and school systems, so that materials are designed to meet real-world needs, and so that there is a healthy marketplace of alternatives from which to choose.

Two major solicitations have been directed to the development of early mathematics and science materials in cooperation with commercial publishers. In future years, the program expects to pursue further partnerships for materials at the high school level.

The subactivity also invests in longer-term research efforts to increase our understanding of how children learn these subjects and how they may be better taught through the use of advanced educational technology. As the application of artificial intelligence techniques increases, for example, we may be able to provide a "tutor in a box" that can help the gifted, or isolated, or slower students to pursue additional study, or progress through lessons at their own pace.

Similarly, if we understand the patterns of effective learning and the critical obstacles to skills and understanding, we may be able to teach mathematics and science more efficiently and successfully for a larger portion of the whole population.

The subactivity includes four components:

- o Instructional Materials Development encourages the most capable scientists, educators, school systems and publishers to cooperate in developing new and improved instructional materials and methods.
- o Informal Science Education encourages informal learning through mass media programs that reach large portions of the population efficiently and effectively, together with science museum exhibits and activities that provide hands-on experience, and science-related programs of recreational organizations like the Girls Clubs and Girl Scouts.
- o Applications of Advanced Technologies encourages research and development in the creation, design and application of advanced computer technology for instruction, including prototypes of new hardware, software, systems and languages.
- o Research in Teaching and Learning encourages basic and applied research to examine the factors that promote successful teaching and learning of mathematics and science.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)				
	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Materials Development, Research and Informal Science Education.....	\$22.7	\$25.0	\$ 2.3	10.1%

The FY 1986 Current Plan is \$2,300,000 more than the FY 1986 Budget Request of \$22,700,000 due to an increase in the appropriation for the SEE Activity. These funds will augment the emphasis on early involvement of publishers as partners in materials development and augment the activities of science museums in informal education.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Materials Development, Research and Informal Science	\$25.0	\$25.0	\$ 0.00	0.0%

The FY 1987 budget request is unchanged from the FY 1986 Current Plan. It will continue to support projects which encourage new and improved mathematics and science learning at early ages, both to establish early science literacy and to provide a base line for later study and careers.

Primary focus will continue to emphasize: 1) materials development thrusts in both early mathematics and science, 2) strong involvement of publishers as partners in the funding and development of new materials, 3) use of television and other cost-effective educational technologies, and 4) expanded activities by science museums as partners in informal science education.

CHANGES IN BUDGET STRUCTURE

See *Changes in Budget Structure* section of *Science and Engineering Education Summary of Request*.

TEACHER PREPARATION AND ENHANCEMENT ... 27,000,000**SUMMARY OF REQUEST**

Support for the preparation and continuing professional development of elementary and secondary science and mathematics teachers and the development of resource-sharing networks remains constant at \$27.0 million.

Subactivity	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
Teacher Preparation and Enhancement.....	\$25,188,387	\$24,000,000	\$27,000,000	\$27,000,000	\$0

SCIENTIFIC OVERVIEW

Among the issues of concern for elementary and secondary school teaching in sciences and mathematics are the lack of prestige, professionalism, and preparation of many teachers. These are areas where a Federal leadership role is essential in drawing attention to the importance and centrality of the teacher and providing models that use outstanding scientists, science educators, and teachers to improve the profession as a whole.

NSF-supported projects involve active collaboration among scientists, science educators, and teachers for both teacher preparation and in-service teacher professional development; activities, such as summer/academic year workshops, that enrich teachers' and supervisors' backgrounds and teaching skills; extensive use of leadership teachers and supervisors in the mentoring, support, and continuing education of their peers; cooperative arrangements among local and state education agencies, colleges and universities, private business and industry, professional organizations, and informal science institutions; and, lasting colleague-colleague relationships among teachers and scientists for long-term support and encouragement. Projects supported are designed to develop, apply, and assess approaches based on the results of research in teaching and learning that show promise of adding to this store of knowledge about effective activities for teacher professional development. The anticipated outcomes are better prepared and highly motivated teachers and an increased recognition of and reliance on teacher expertise, i.e., increased professional status.

Presidential awards for excellence in science and mathematics teaching provide national recognition for distinguished secondary school teachers of science and mathematics and for the methods they use in their classrooms. Increased professional status and awards to their schools provide strong incentives for high-quality teachers to enter and remain in their field. Dissemination of information about methods that these teachers find successful helps other teachers develop their own, more effective approaches.

SEE - III - 1

Teacher Preparation seeks to develop and evaluate exemplary programs that strengthen the preparation of teachers in the content of science and mathematics, in the knowledge and skills of effective teaching techniques, and in the integrated use of advanced technologies in instruction and that are suitable for widespread adoption by other teacher education institutions. A portion of the funds in this component is used to support targeted proposal solicitations; the present emphasis is on preparation of middle school science and mathematics teachers, an area in which very few academic programs now exist.

Teacher Enhancement provides various means for developing and testing creative continuing education models, including the use of advanced technologies; for identifying and recognizing outstanding leadership teachers and supervisors, and training them to provide in-service assistance to their colleagues; for encouraging local educational agencies to give these teachers the support necessary to carry out their in-service role; and for assessing the results in ways that enhance classroom application and provide evidence for the effectiveness, in terms of more and better science education, of the models developed.

Science and Mathematics Education Networking provides dissemination opportunities, including local and regional information- and resource-sharing networks that actively involve elementary, secondary, and college teachers and scientists in exchanging and integrating successful approaches, materials, and methods into their own teaching. An information brokering role is assumed by the NSF in helping networks develop that serve local needs and retain local control while providing a much richer set of opportunities and examples from which to select to solve local problems.

The Department of Education also administers programs that provide state and local educational agencies, colleges and universities, and informal educational agencies with an additional and complementary source of funding for elementary and secondary science and mathematics education activities. The NSF works with the Department to ensure coordination and collaboration consistent with the goals and purposes of the two agencies and the Education for Economic Security Act.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)				
Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Teacher Preparation and Enhancement	\$25.00	\$27.00	\$ 2.00	8.0%

The FY 1986 Current Plan is \$2,000,000 more than the FY 1986 Budget Request of \$25,000,000 due to an increase in the appropriation for the Activity. The increase will be used for support of in-service teacher enhancement.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Teacher Preparation and Enhancement	\$27.00	\$27.00	\$ 0.00	0.0%

The initiatives begun over the past two years will be continued in FY 1987. Informed by the results of program assessments, the Activity will develop new targeted proposal solicitations for a portion of the funds.

CHANGES IN BUDGET STRUCTURE

See *Changes in Budget Structure* section of *Science and Engineering Education Summary of Request*.

STUDIES AND PROGRAM ASSESSMENT.....\$ 2,200,000**SUMMARY OF REQUEST**

Support for studies and analyses of the condition of science and mathematics education and for assessment of NSF science and engineering education programs remains constant at \$2.2 million.

Program Element	Actual	Request	Current	Estimate	Difference
	FY 1985	FY 1986	FY 1986	FY 1987	FY 1987/86
Studies and Program Assessment.....	\$1,747,713	\$2,000,000	\$2,200,000	\$2,200,000	\$0

SCIENTIFIC OVERVIEW

The goal of this program is to serve a major role in policy formulation for strengthening science and engineering education in the U.S. and to provide support for leadership efforts of the Foundation in science and engineering education activities. The program conducts (1) studies of the condition of science and mathematics education in the U.S., and (2) evaluations of NSF's science and engineering education programs to assist the Foundation in assessing advantages and disadvantages of alternative programmatic initiatives.

To undergird efforts to improve and strengthen science and mathematics education, data on their condition and changes over time are needed. Choices and policy decisions by local and state education agencies and local, state, and national governing bodies can then be made on an informed basis. The NSF supports studies and analyses of existing, new, and improved educational data bases that provide systematic and continuing understanding of the condition of science and mathematics education in the U.S.

Among the important reasons for supporting studies are to:

- o Maintain a national mechanism to measure student achievement and participation in precollege science and mathematics in the U.S. and to publish findings in reports such as the National Science Board publication, Science Indicators;
- o Develop and validate indicators that allow national, state and local evaluation and comparison of educational progress and assistance to interested Federal and non-Federal agencies in planning relevant data collections and analyses;
- o Analyze international assessments of student achievement for comparison purposes and provide information concerning the factors responsible for differences from one country and educational system to another; and

- o Develop and validate indicators of teacher quality that get at the factors beyond educational background and certification that make teachers more or less effective in the classroom.

NSF recognizes that the Department of Education has statutory responsibility for the collection of primary data on student achievement and participation. In these areas, NSF's role is to coordinate survey and evaluation projects with the Department, rather than performing its own primary data collection. In areas of special interest to science education, NSF sponsors enhancements (e.g., enlarged sample sizes, experiments in developing new testing procedures and analyses, and interpretation of data) through ongoing Department studies.

NSF is also responsible for designing and implementing systematic evaluations of the Foundation's science, mathematics and engineering education programs. NSF needs to assess the impact of its past and present support for science and mathematics education in order to provide a firm basis for decisions to extend and/or reformulate the science education long-range plan that was put into place beginning in FY 1984.

The major effort in assessment of present NSF initiatives involves the Congressionally-mandated \$2 million contract study for developing the science education plan and its management. Planning and assessment are strongly linked because the on-going formulation of NSF science mathematics and engineering education strategies, the subactivities, their components, and their objectives, must be based on knowledge of the impact of NSF support. The results of the studies on the condition of science and mathematics education, teacher quality, and other issues that will be examined in the future, also provide information for this planning.

A part of the study, focusing on middle school science, is already under way with results and recommendations due during FY 1986. A contract for the remainder of the study will be awarded early in calendar year 1986. The study tasks are to (1) briefly review prior NSF and other evaluations of science education programs, (2) work closely with NSF Science and Engineering Education staff to clarify program goals and state them in measurable terms, (3) assess the advantages and disadvantages of the initiatives NSF has chosen to reach these goals (and alternative initiatives the contractor may suggest), and (4) design plans for the NSF to assess the quality and impact of its education programs.

The contractor will use the suggested methods to do a pilot assessment of one program. The study plans will also serve as a basis for conducting systematic evaluations of NSF's science and engineering education programs on an on-going basis and result in an increased NSF capability to define science and engineering education program goals, assess the initiatives taken to meet these goals and, informed by ongoing assessment, make necessary changes in these initiatives.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
Studies and Program Assessment.....	\$02.00	\$ 2.20	\$ 0.20	10.0%

The FY 1986 Current Plan is \$200,000 more than the FY 1986 Budget Request of \$2,000,000 due to an increase in the appropriation for the SEE Activity. These funds will be used to increase program evaluation and assessment activities that will lay the groundwork and provide baseline information for later, more extensive assessment.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
Studies and Program Assessment... ..	\$02.20	\$ 2.20	\$ 0.00	0.0%

The emphasis on program evaluation and assessment will continue, informed by previous studies and the results from the contract study.

COLLEGE SCIENCE INSTRUMENTATION \$ 7,500,000**SUMMARY OF REQUEST**

Support for instrumentation-based undergraduate laboratory development is increased by 36 percent from \$5.5 million to \$7.5 million.

Program Element	Actual FY 1985	Request FY 1986	Current Plan FY 1986	Estimate FY 1987	Difference FY 1987/86
College Science Instrumentation	\$4,996,379	\$5,000,000	\$5,500,000	\$7,500,000	\$2,000,000

SCIENTIFIC OVERVIEW

The undergraduate or college-level years stand squarely in the middle of the educational process in the United States. At their beginning they touch the high schools, which take responsibility for many students as they emerge from our highly diverse public and private school systems. At the other end they feed the graduate research programs and universities, industries, the professions, and the society for whom these institutions have prepared their students.

The laboratory experience is a central and essential element in the undergraduate education of students in science and engineering. The quality and effectiveness of the overall curriculum in science and engineering is strongly dependent on the strength and currency of the laboratory component.

Currently, the NSF role in undergraduate science, mathematics, and engineering education focuses on the quality of laboratory instruction in:

- o the Nation's four-year colleges, and
- o the engineering disciplines at all colleges and universities.

The four-year colleges traditionally have had an extraordinary track record in producing outstanding graduates who become top scientists and leaders of business, government, and the professions. Their ability to maintain high quality laboratory instruction has been strongly taxed by the rapid advance of science and technology. In the engineering disciplines, keeping pace with these changes has been especially difficult. Few engineering schools have managed to maintain the quality of laboratory instruction necessary to respond to sophisticated new technologies.

There are strong indicators that the quality of undergraduate science and engineering laboratory instruction has deteriorated significantly in recent years. Reports from several sources, including the National Society of Professional Engineers, the American Chemical Society, and the American Physical Society point with alarm to the quality of laboratories, and generally describe instrumentation as the most critical need in undergraduate instruction. A specially appointed committee of the National Science Board is examining the U.S. system of undergraduate science and engineering education to determine an appropriate NSF role in this important area.

The NSF has been able to make a significant impact in this area with a relatively small investment through the College Science Instrumentation Program (CSIP). In its role of leveraging funds, the CSIP award budgets are more than matched by local and industrial sources, effectively doubling the impact of the program, and serving in many cases to establish partnerships between the colleges and the private sector.

CSIP provides competitive, merit-based support for the improvement of undergraduate science laboratories and curricula through:

- o Introduction of modern instruments to improve the experiences of undergraduate students in science and engineering courses, laboratories, and field work;
- o Interfacing of computers with scientific instrumentation and other appropriate uses of current technology in science and engineering instruction;
- o Development of new instrumentation that extends instructional capabilities; and
- o Establishment of equipment sharing capability via consortia or centers.

In its first year of operation, FY 1985, CSIP made over 200 awards from among more than 1300 proposals to colleges in 42 states and Puerto Rico. The awards touched all of the major science and engineering disciplines. Included among the projects were computer aided design and manufacturing laboratories in engineering, nuclear magnetic resonance spectroscopy studies in chemistry, and laser-based experiments in physics. Institutions that competed successfully included church-related and independent liberal arts colleges, regional state colleges, historically minority institutions, and women's colleges.

CSIP staff carefully coordinate their activities with the research instrumentation support conducted throughout NSF, and in FY 1985 several projects were funded cooperatively with NSF's Chemistry subactivity. There currently exists no Federal mechanism other than NSF's College Science Instrumentation Program responding to the need for revitalized undergraduate science and engineering instructional instrumentation in the Nation's colleges and universities.

CHANGES BETWEEN THE FY 1986 REQUEST AND THE FY 1986 CURRENT PLAN

(Millions of Dollars)

Program Element	FY 1986 Request	FY 1986 Current Plan	Change	
			Amount	Percent
College Science Instrumentation.....	\$ 5.00	\$ 5.50	\$ 0.50	10.0%

The FY 1986 Current Plan is \$500,000 more than the FY 1986 Budget Request of \$5,000,000 due to an increase in the appropriation for the SEE Activity. These funds will be used to support approximately 20 additional projects.

FY 1987 BUDGET HIGHLIGHTS

(Millions of Dollars)

Program Element	FY 1986 Current Plan	FY 1987 Request	Change	
			Amount	Percent
College Science Instrumentation.....	\$ 5.50	\$ 7.50	\$ 2.00	36.4%

In FY 1987, \$3.0 million of the College Science Instrumentation subactivity funds will be reserved for the engineering disciplines, because of their especially severe needs for improved instrumentation-based laboratory instruction. Engineering schools are lacking technologically up-to-date equipment, e.g. robots, programmable testing equipment, analog simulators, and lasers, and are continuing to use old and obsolete equipment. This focus will begin to remedy that situation and produce corresponding improvements in undergraduate engineering curricula.

SPECIAL FOREIGN CURRENCY \$ 700,000**SUMMARY OF REQUEST**

Activity	Actual	Request	Current	Estimate	Difference
	FY 1985	FY 1986	Plan FY 1986	FY 1987	FY 1987/86
Special Foreign Currency Program	\$2,828,305	\$1,000,000	\$1,002,417	\$700,000	(\$302,417)

NSF ROLE

The Special Foreign Currency activity serves U.S. scientific and foreign relations goals in Pakistan (the only country currently participating) by using local currency to support scientific cooperation. Costs of such cooperation incurred in Pakistan, as well as the international travel to Pakistan of U.S. scientists and engineers, are supported. This activity thus benefits the U.S. scientific and engineering community at no cost in dollars while promoting U.S.-Pakistani cooperation consistent with U.S. foreign policy. Scientific cooperation with India, also previously supported in part through use of such local currency, is now supported through an alternate mechanism, the U.S.-India Fund for Cultural, Educational and Scientific Cooperation, which provides for costs of cooperative activities incurred in India as well as international travel.

CHANGES BETWEEN THE FY 1986 BUDGET REQUEST AND FY 1986 CURRENT PLAN

The FY 1986 Current Plan for Special Foreign Currency is \$1,002,417. The small increase of \$2,417 above the FY 1986 Request of \$1 million incorporates carryover funds from FY 1985.

FY 1987 BUDGET HIGHLIGHTS

The FY 1987 Request of \$700,000 in Special Foreign Currency is a decrease of 30.2 percent from the FY 1986 Current Plan and reflects the systematic use and depletion of available "excess" currency, as controlled by the Department of the Treasury. In FY 1987, resources will be used entirely for collaborative activities with Pakistan which are important scientifically in a growing number of fields, including natural products chemistry, water resources engineering, geology of the Himalayas, materials science and metallurgy, remote sensing, oceanography, and seismic studies. Through this activity NSF supports cooperative research, seminars and scientific visits, with topical eligibility in all science and engineering fields but with concentration on areas of research involving unique resource sites and those indicated above.

CROSS-DIRECTORATE PROGRAMS

INTRODUCTION

This section provides information on the Foundation's Cross-Directorate Programs. The budgets for these programs are included in the appropriate Activity estimates: they are shown here in summary form for ease of reference. As described more fully below, each of these programs involves two or more of the Foundation's disciplinary research activities. The distinctions between the categories generally reflect the degree to which external targets or management controls are required for the program.

SPECIAL INTERDISCIPLINARY SCIENTIFIC RESEARCH OPPORTUNITIES

The special interdisciplinary scientific research opportunities are research-driven activities which arise from the research community itself. Proposals are unsolicited, and the usual review procedures govern awards.

These activities are budgeted by the research directorates. In each case, one of the participating directorates is assigned overall management and monitoring responsibility. In FY 1987, three thrusts are included:

- o Biotechnology (BBS lead directorate)
- o Computational Science and Engineering (MPS lead directorate)
- o Global Geosciences (AAEO lead directorate)

A summary budget table is given below. Detailed discussions of these efforts are given in the Budget Summary and in each of the individual Activity justifications.

Special Interdisciplinary Scientific Research Opportunities

<i>Program</i>	<i>Actual FY 1985</i>	<i>Estimate FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
Biotechnology.....	\$81,487,930	\$86,487,930	\$106,487,930	\$20,000,000
Computational Science and Engineering.....	54,742,500	56,900,000	83,900,000	27,000,000
Global Geosciences.....	16,000,000	17,300,000	35,580,000	18,280,000
TOTAL, NSF.....	\$152,230,430	\$160,687,930	\$225,967,930	\$65,280,000

**CROSS-DIRECTORATE PROGRAMS BUDGETED WITHIN THE SCIENTIFIC,
TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS (STIA) DIRECTORATE**

These programs, budgeted and managed by STIA, involve the disciplinary research directorates in their operation and generally involve some type of central coordination. In some cases, this involvement reflects the nature of the activity itself: international cooperative research, because of the need for formal diplomatic activities, is a prime example. More commonly, however, these programs are designed to augment or enhance the position of underrepresented groups or institutions in research activity. They serve as a special subset of the Foundation's overall efforts to improve the participation of women, minorities, and small businesses in its research support. Separate program announcements are made and special criteria are used in reviewing proposals for these programs.

Programs included are:

- o International Cooperative Research Activities;
- o Minority Research Centers of Excellence;
- o Research Improvement in Minority Institutions;
- o Small Business Innovation Research; and
- o Visiting Professorships for Women.

A summary budget table for these programs is given below. Detailed discussions of these programs are included under the justification for the STIA activity.

Cross-Directorate Programs Budgeted Within STIA

<i>Program</i>	<i>Actual FY 1985</i>	<i>Estimate FY 1986</i>	<i>Estimate FY 1987</i>	<i>Difference FY 1987/86</i>
International Cooperative Research Activities.....	\$12,422,241	\$10,840,000	\$12,660,000	\$1,820,000
Minority Research Centers of Excellence.....	0	0	4,000,000	4,000,000
Research Improvement in Minority Institutions.....	4,948,272	4,990,000	4,990,000	0
Small Business Innovation Research.....	12,399,992	15,650,000	17,150,000	1,500,000
Visiting Professorships for Women.....	2,142,524	2,000,000	2,000,000	0
TOTAL, NSF.....	\$31,913,029	\$33,480,000	\$40,800,000	\$7,320,000

CROSS-DIRECTORATE PROGRAMS BUDGETED WITHIN THE RESEARCH DIRECTORATES

The cross-directorate programs budgeted within the research directorates straddle the two previous categories. They require enough coordination to have a designated management entity; yet their activities are sufficiently integrated within routine directorate activities so that specific directorate targets can be developed. Some of the programs are transitional activities in the process of being "mainstreamed."

This category includes several programs that are designed to address problems associated with the Nation's scientific and engineering infrastructure. It includes special programs for women and minority scientists, young investigators, undergraduate institutions, industry/university cooperative research, and awards to states that are relatively less successful in competing for research funds. Specific programs included are:

- o Experimental Program to Stimulate Competitive Research;
- o Industry/University Cooperative Research Projects;
- o Minority Research Initiation;
- o Predominantly Undergraduate Institutions;
- o Presidential Young Investigators; and
- o Research Opportunities for Women.

In several cases, overall management and monitoring responsibility is vested in the Scientific, Technological, and International Affairs (STIA) directorate; the Presidential Young Investigators program is coordinated by Science and Engineering Education; and Industry/University Cooperative Research Projects is coordinated by the Engineering Directorate. A summary budget table, descriptions, and budget highlights for the programs in this category are given below.

Cross-Directorate Programs Budgeted Within the Research Directorates

<i>Program</i>	<i>Target FY 1985</i>	<i>Target FY 1986</i>	<i>Target FY 1987</i>	<i>Difference FY 1987/86</i>
Experimental Program to Stimulate Competitive Research....	\$1,000,000	\$2,000,000	\$4,000,000	\$2,000,000
Industry/University Cooperative Research.....	13,980,000	12,000,000	9,937,000	(2,063,000)
Minority Research Initiation..	2,500,000	2,500,000	2,700,000	200,000
Predominantly Undergraduate Institutions.....	42,400,000	44,200,000	47,000,000	2,800,000
Presidential Young Investigators.....	22,900,000	25,500,000	37,500,000	12,000,000
Research Opportunities for Women.....	500,000	2,200,000	2,450,000	250,000
TOTAL, NSF.....	\$83,280,000	\$88,400,000	\$103,587,000	\$15,187,000

*Program Descriptions and FY 1987 Budget Highlights for
Cross-Directorate Programs Budgeted Within the Research Directorates*

- o Experimental Program to Stimulate Competitive Research (EPSCoR) provides funding incentives for states that are relatively less successful in competing for research funds by involving academic and industrial leaders in the states with the design and execution of long range research improvement plans. This program was originally initiated in 1978 to assist 5 states. In FY 1986, 11 additional states and Puerto Rico will receive planning grants from NSF to develop implementation programs for improving basic science and engineering research. In FY 1986 and FY 1987, up to 8 of these states will be awarded continuing grants of up to \$3 million each to implement their plans over a 4-to-5-year period. The ability of these states to make significant enhancements in the current quality of their research programs and their willingness to invest significant local resources in the EPSCoR effort are key criteria in selecting the awards. This program's support is doubled, moving from \$2.0 million in FY 1986 to \$4.0 million in FY 1987.

 - o Industry/University Cooperative Research Projects (IUCR) seeks to foster stronger industry/university interactions by supporting fundamental research that underlies new technologies and links the ideas, skills, and facilities of the participating researchers. In FY 1986, about 25 percent of the funds for this program, or \$3.0 million, is included as a program element under the Cross-Disciplinary Research Subactivity in Engineering. These funds are used to match the other 75 percent of funds for this program from the research directorates (including Engineering).
- In FY 1987, the matching-funds program in Engineering will be eliminated since it has achieved its objective of stimulating cooperative industry/university research within the directorates. Completion of currently funded projects will still require nearly \$10 million in FY 1987. Proposals for industry/university cooperative research will still be eligible for support under regular ongoing research programs in FY 1987 and beyond. Expansion of industry-university relationships in the Engineering Research Centers, Materials Research Groups, Biotechnology Centers, Presidential Young Investigators, and other programs will compensate several times over for the termination of the IUCR Program.
- o Minority Research Initiation (MRI) supports research undertaken by scientists and engineers who are members of minority groups underrepresented in science careers and who have not previously received Federal research support. In FY 1985, actual funding for this program exceeded the target of \$2.5 million by nearly \$200,000. The FY 1987 funding target for this program increases by 8 percent, from \$2.5 million in FY 1986 to \$2.7 million in FY 1987.

- o Predominantly Undergraduate Institutions (PUI) support includes all NSF scientific and engineering research awards to predominantly undergraduate colleges and universities. Included in this general category of support are Research in Undergraduate Institutions (RUI), which specifically targets non-doctoral institutions and departments, and Research Opportunity Awards (ROA), which permit faculty members from undergraduate institutions to participate in research at major research institutions. Funds are provided for faculty research, instrumentation, and other activities that strengthen the research and teaching capabilities of the Nation's undergraduate institutions. In FY 1985, actual funding for this effort exceeded the target of \$42.4 million by about \$4.6 million. The funding target for this effort is increased by 6.3 percent, from \$44.2 million in FY 1986 to \$47.0 million in FY 1987.
- o Presidential Young Investigators (PYI), initiated in FY 1984, provides research support to the Nation's most promising young science and engineering faculty members. The awards, which generally combine NSF and industrial support, are intended to encourage promising young scientists and engineers, those within four years beyond the Ph.D., to select and remain in academic careers. The original FY 1985 estimate for this program assumed that a high level of matching funds from industry would be obtained by the investigators prior to the end of FY 1985. However, a significant portion of the anticipated industrial matching funds was not obtained until FY 1986. The original FY 1985 estimate of \$22.9 million was therefore substantially above the actual FY 1985 obligations of about \$16.5 million. In FY 1987, 200 new awards will be made, bringing the total number of PYI awards to about 700. FY 1987 support will increase from \$25.5 million in FY 1986 to \$37.5 million, or by 47 percent. About half of the awards will support young researchers in engineering.
- o Research Opportunities for Women (ROW) supports research undertaken by women who have not previously received Federal support as principal investigators or whose careers have been interrupted, to help them develop as independent researchers. In FY 1985, actual funding for this program substantially exceeded the original targets. Funding targets for this program are increased by 11 percent, from \$2.2 million in FY 1986 to \$2.45 million in FY 1987.

National Science Foundation

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$1,261,807,119	\$1,312,354,598	\$1,422,561,000
Applied Research.....	83,775,864	81,530,127	85,719,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	1,345,582,983	1,393,884,725	1,508,280,000
(Conduct of R&D Performed by Colleges and Universities.)..	(1,003,515,968)	(1,041,543,544)	(1,143,065,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	18,696,280	19,209,500	24,410,000
Major Equipment.....	54,861,530	51,408,328	59,564,000
Subtotal, R&D Facilities & Major Equipment	73,557,810	70,617,828	83,974,000
Total, Support of R&D.....	1,419,140,793	1,464,502,553	1,592,254,000
Education and Training.....	82,801,901	87,404,325	89,434,000
Collection of Information.....	5,127,515	3,701,000	4,012,000
TOTAL.....	\$1,507,070,209	\$1,555,607,878	\$1,685,700,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	37,857	39,267	41,853
Dollars Requested (Total).....	\$10,258,356,621	\$8,270,901,049	\$8,707,863,112
Awards Summary			
Number of Awards.....	14,157	14,041	14,713
Dollars Obligated (Total).....	1,507,070,209	1,555,607,878	1,685,700,000
Dollar Distribution by Performer			
Universities.....	1,089,750,178	1,129,043,869	1,237,896,000
Industry.....	55,379,881	58,569,000	66,609,000
Federal Agencies.....	85,699,955	88,694,480	87,139,000
Other.....	276,240,195	279,300,529	294,056,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	14,986	15,150	15,875
Amount of Scientist Support.....	176,103,932	181,606,659	195,762,000
Number of Years of Scientist Support.....	3,740	3,794	3,995
Postdoctoral Support			
Number of Postdoctorals Supported.....	3,469	3,515	3,660
Amount Postdoctoral Support.....	57,540,203	59,827,000	64,302,000
Graduate Students			
Number of Graduate Students Supported.....	13,448	13,738	14,589
Amount Graduate Student Support.....	130,784,987	134,762,653	145,016,000
Other Personnel Costs			
Amount of Support.....	226,184,461	233,268,156	245,149,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	17,832,865	18,267,000	23,396,000
Major Equipment.....	52,271,765	48,943,328	56,756,000
Other Equipment and Instrumentation.....	166,584,010	174,592,200	203,088,000
Other Direct Research Costs*	328,153,242	341,512,682	361,294,000
Indirect Costs.....	351,634,744	362,828,200	390,967,000
TOTAL.....	\$1,507,070,209	\$1,555,607,878	\$1,685,700,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Research and Related Activities**Research and Development Special Analysis**

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$1,156,839,930	\$1,205,153,468	\$1,317,498,000
Applied Research.....	80,121,873	77,981,000	82,283,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	1,236,961,803	1,283,134,468	1,399,781,000
(Conduct of R&D Performed by Colleges and Universities.)..	(990,644,021)	(1,029,222,968)	(1,130,504,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	10,696,280	10,209,500	11,610,000
Major Equipment.....	54,761,649	51,373,000	59,539,000
Subtotal, R&D Facilities & Major Equipment	65,457,929	61,582,500	71,149,000
Total, Support of R&D.....	1,302,419,732	1,344,716,968	1,470,930,000
Education and Training.....	3,957,319	4,060,000	4,134,000
Collection of Information.....	5,067,249	3,625,000	3,936,000
TOTAL.....	\$1,311,444,300	\$1,352,401,968	\$1,479,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	29,052	30,281	32,377
Dollars Requested (Total).....	\$9,365,610,975	\$7,302,231,249	\$7,718,456,312
Action Summary			
Number of Awards.....	13,399	13,040	13,626
Dollars Obligated (Total).....	1,311,444,300	1,352,401,968	1,479,000,000
Dollar Distribution by Performer			
Universities.....	1,014,384,827	1,051,078,968	1,157,835,000
Industry.....	32,228,983	34,482,000	38,406,000
Other.....	7,105,065	7,222,000	8,429,000
	257,725,425	259,619,000	274,330,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	14,038	14,226	14,957
Amount of Scientist Support.....	158,414,756	163,929,500	178,214,000
Number of Years of Scientist Support.....	3,378	3,422	3,626
Postdoctoral Support			
Number of Postdoctorals Supported.....	3,425	3,469	3,614
Amount Postdoctoral Support.....	56,521,702	58,728,000	63,190,000
Graduate Students			
Number of Graduate Students Supported.....	11,543	11,838	12,709
Amount Graduate Student Support.....	102,338,183	106,415,000	116,891,000
Other Personnel Costs			
Amount of Support.....	188,484,633	193,860,500	205,320,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	9,832,865	9,267,000	10,596,000
Major Equipment.....	52,171,884	48,908,000	56,731,000
Other Equipment and Instrumentation.....	146,499,522	153,378,200	179,668,000
Other Direct Research Costs*	257,510,688	267,980,768	290,460,000
Indirect Costs.....	339,670,047	349,935,000	377,930,000
TOTAL.....	\$1,311,444,300	\$1,352,401,968	\$1,479,000,000
*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.			

Mathematical and Physical Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$363,550,864	\$377,347,000	\$411,780,000
Applied Research.....	11,391,356	11,858,000	12,512,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	374,942,220	389,205,000	424,292,000
(Conduct of R&D Performed by Colleges and Universities.)..	(364,299,601)	(378,399,000)	(412,790,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	600,000	615,000	658,000
Major Equipment.....	21,645,867	20,150,000	24,300,000
Subtotal, R&D Facilities & Major Equipment	22,245,867	20,765,000	24,958,000
Total, Support of R&D.....	397,188,087	409,970,000	449,250,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$397,188,087	\$409,970,000	\$449,250,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	6,718	6,957	7,355
Dollars Requested (Total).....	\$1,556,076,798	\$1,632,614,000	\$1,757,081,850
Action Summary			
Number of Awards.....	3,926	3,915	4,031
Dollars Obligated (Total).....	397,188,087	409,970,000	449,250,000
Average Award Size.....	101,169	104,722	111,452
Dollar Distribution by Performer			
Universities.....	386,683,398	399,305,000	437,891,000
Industry.....	912,198	935,000	1,023,000
Federal Agencies.....	1,268,010	1,192,000	1,293,000
Other.....	8,324,481	8,538,000	9,043,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	4,691	4,709	4,872
Amount of Scientist Support.....	47,194,115	49,219,000	53,475,000
Number of Years of Scientist Support.....	877	888	912
Postdoctoral Support			
Number of Postdoctorals Supported.....	1,672	1,696	1,766
Amount Postdoctoral Support.....	28,979,476	30,540,000	33,163,000
Graduate Students			
Number of Graduate Students Supported.....	5,062	5,167	5,532
Amount Graduate Student Support.....	42,366,186	44,482,000	49,332,000
Other Personnel Costs			
Amount of Support.....	38,467,303	39,391,000	42,538,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	600,000	615,000	658,000
Major Equipment.....	21,645,867	20,150,000	24,300,000
Other Equipment and Instrumentation.....	66,544,700	69,477,000	74,282,000
Other Direct Research Costs*	56,414,825	57,639,000	64,035,000
Indirect Costs.....	94,975,615	98,457,000	107,467,000
TOTAL.....	\$397,188,087	\$409,970,000	\$449,250,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Mathematical Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$47,674,147	\$51,680,000	\$59,130,000
Applied Research.....	55,657	60,000	70,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	47,729,804	\$1,740,000	\$9,800,000
(Conduct of R&D Performed by Colleges and Universities.)..	(41,871,798)	(45,740,000)	(53,300,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	47,729,804	\$1,740,000	\$9,800,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$47,729,804	\$51,740,000	\$59,800,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	2,007	2,100	2,200
Dollars Requested (Total).....	\$195,281,000	\$205,000,000	\$220,000,000
Action Summary			
Number of Awards.....	1,167	1,170	1,180
Dollars Obligated (Total).....	47,729,804	\$1,740,000	\$9,800,000
Average Award Size.....	40,900	44,222	50,678
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	41,871,798	45,740,000	53,300,000
Industry.....	0	0	0
Federal Agencies.....	2,500	0	0
Other.....	5,855,306	6,300,000	6,300,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	1,310	1,300	1,330
Amount of Scientist Support.....	14,566,412	15,400,000	17,100,000
Number of Years of Scientist Support.....	243	243	247
Postdoctoral Support			
Number of Postdoctorals Supported.....	225	240	255
Amount Postdoctoral Support.....	4,369,614	4,900,000	5,650,000
Graduate Students			
Number of Graduate Students Supported.....	873	750	875
Amount Graduate Student Support.....	3,371,900	4,200,000	5,400,000
Other Personnel Costs			
Amount of Support.....	4,377,755	4,700,000	5,400,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	1,722,000	2,190,000	2,850,000
Other Direct Research Costs*	6,603,032	7,300,000	7,900,000
Indirect Costs.....	12,719,091	13,550,000	15,500,000
TOTAL.....	\$47,729,804	\$51,740,000	\$59,800,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Computer Research

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$31,511,661	\$32,551,000	\$37,164,000
Applied Research.....	66,919	69,000	76,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	31,578,580	32,620,000	37,240,000
(Conduct of R&D Performed by Colleges and Universities)...	(30,762,907)	(31,865,000)	(36,427,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	7,545,867	7,550,000	7,200,000
Subtotal, R&D Facilities & Major Equipment.....	7,545,867	7,550,000	7,200,000
Total, Support of R&D.....	39,124,447	40,170,000	44,440,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$39,124,447	\$40,170,000	\$44,440,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	752	772	854
Dollars Requested (Total).....	\$234,000,000	\$240,253,000	\$265,792,000
Action Summary			
Number of Awards.....	352	350	365
Dollars Obligated (Total).....	39,124,447	40,170,000	44,440,000
Average Award Size.....	111,149	114,771	121,753
Average Award Duration (Years).....	1.3	1.3	1.3
Dollar Distribution by Performer			
Universities.....	38,308,774	39,436,000	43,627,000
Industry.....	79,248	81,000	90,000
Federal Agencies.....	100,000	0	0
Other.....	636,425	653,000	723,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	382	380	400
Amount of Scientist Support.....	5,066,472	5,229,000	5,752,000
Number of Years of Scientist Support.....	88	88	93
Postdoctoral Support			
Number of Postdoctorals Supported.....	26	26	26
Amount Postdoctoral Support.....	418,006	431,000	449,000
Graduate Students			
Number of Graduate Students Supported.....	483	496	549
Amount Graduate Student Support.....	5,314,440	5,632,000	6,490,000
Other Personnel Costs			
Amount of Support.....	5,076,870	5,051,000	5,667,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	7,545,867	7,550,000	7,200,000
Other Equipment and Instrumentation.....	1,700,000	1,745,000	2,665,000
Other Direct Research Costs*	4,674,248	4,862,000	5,423,000
Indirect Costs.....	9,328,544	9,670,000	10,794,000
TOTAL.....	\$39,124,447	\$40,170,000	\$44,440,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Physics

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$96,795,000	\$100,830,000	\$104,220,000
Applied Research.....	4,900,000	5,200,000	5,320,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	101,695,000	106,030,000	109,540,000
(Conduct of R&D Performed by Colleges and Universities)...	(101,600,000)	(105,930,000)	(109,440,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	14,100,000	12,600,000	17,100,000
Subtotal, R&D Facilities & Major Equipment.....	14,100,000	12,600,000	17,100,000
Total, Support of R&D.....	115,795,000	118,630,000	126,640,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$115,795,000	\$118,630,000	\$126,640,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	873	933	954
Dollars Requested (Total).....	\$453,460,000	\$477,460,000	\$499,450,000
Action Summary			
Number of Awards.....	526	520	521
Dollars Obligated (Total).....	115,795,000	118,630,000	126,640,000
Average Award Size.....	219,309	228,135	243,371
Average Award Duration (Years).....	1.0	1.2	1.0
Dollar Distribution by Performer			
Universities.....	115,535,000	118,360,000	126,350,000
Industry.....	0	0	0
Federal Agencies.....	100,000	100,000	110,000
Other.....	160,000	170,000	180,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	961	881	880
Amount of Scientist Support.....	10,300,000	11,100,000	11,750,000
Number of Years of Scientist Support.....	209	216	215
Postdoctoral Support			
Number of Postdoctorals Supported.....	348	360	358
Amount Postdoctoral Support.....	7,600,000	8,200,000	8,650,000
Graduate Students			
Number of Graduate Students Supported.....	770	779	734
Amount Graduate Student Support.....	7,000,000	7,500,000	7,300,000
Other Personnel Costs			
Amount of Support.....	10,800,000	10,970,000	11,340,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	14,100,000	12,600,000	17,100,000
Other Equipment and Instrumentation.....	0	24,000,000	23,900,000
Other Direct Research Costs*	19,700,000	19,700,000	20,250,000
Indirect Costs.....	23,495,000	24,560,000	25,750,000
TOTAL.....	\$115,795,000	\$118,630,000	\$126,640,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Chemistry

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$86,513,306	\$88,703,000	\$99,809,000
Applied Research.....	1,050,000	1,077,000	1,211,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	\$7,563,306	\$9,780,000	\$101,020,000
(Conduct of R&D Performed by Colleges and Universities.)..	(\$6,880,636)	(\$9,780,000)	(\$100,232,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	\$7,563,306	\$9,780,000	\$101,020,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$87,563,306	\$89,780,000	\$101,020,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,767	1,800	1,900
Dollars Requested (Total).....	\$263,090,000	\$289,399,000	\$332,808,850
Action Summary			
Number of Awards.....	1,045	1,020	1,050
Dollars Obligated (Total).....	\$7,563,306	\$9,780,000	\$101,020,000
Average Award Size.....	\$3,793	\$8,020	\$9,210
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	\$6,880,636	\$9,080,000	\$100,232,000
Industry.....	330,170	339,000	381,000
Federal Agencies.....	252,500	259,000	291,000
Other.....	100,000	102,000	116,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	896	875	900
Amount of Scientist Support.....	7,000,000	7,177,000	7,836,000
Number of Years of Scientist Support.....	153	150	155
Postdoctoral Support			
Number of Postdoctorals Supported.....	634	620	645
Amount Postdoctoral Support.....	9,490,000	9,730,000	10,623,000
Graduate Students			
Number of Graduate Students Supported.....	1,573	1,540	1,600
Amount Graduate Student Support.....	12,260,000	12,370,000	13,724,000
Other Personnel Costs			
Amount of Support.....	6,790,000	6,962,000	7,601,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	19,490,000	18,958,000	20,698,000
Other Direct Research Costs*	12,460,000	12,775,000	16,226,000
Indirect Costs.....	21,073,306	21,608,000	24,312,000
TOTAL.....	\$87,563,306	\$89,780,000	\$101,020,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Materials Research

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$101,056,750	\$103,583,000	\$110,857,000
Applied Research.....	5,318,780	5,432,000	5,835,000
Development.....	0	0	0
Subtotal, Conduct of Research.....	106,375,530	109,035,000	116,692,000
(Conduct of R&D Performed by Colleges and Universities.)..	(103,184,260)	(105,764,000)	(113,191,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	600,000	615,000	638,000
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	600,000	615,000	638,000
Total, Support of R&D.....	106,975,530	109,650,000	117,330,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$106,975,530	\$109,650,000	\$117,330,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,319	1,352	1,447
Dollars Requested (Total).....	\$410,245,798	\$420,502,000	\$450,231,000
Award Summary			
Number of Awards.....	834	833	915
Dollars Obligated (Total).....	106,975,530	109,650,000	117,330,000
Average Award Size.....	128,268	128,268	128,268
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	104,087,190	106,489,000	114,182,000
Industry.....	502,780	515,000	552,000
Federal Agencies.....	813,010	833,000	992,000
Other.....	1,572,556	1,613,000	1,724,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	1,242	1,273	1,362
Amount of Scientist Support.....	10,061,231	10,313,000	11,037,000
Number of Years of Scientist Support.....	184	189	202
Postdoctoral Support			
Number of Postdoctorals Supported.....	439	450	482
Amount Postdoctoral Support.....	7,101,856	7,279,300	7,791,000
Graduate Students			
Number of Graduate Students Supported.....	1,563	1,602	1,715
Amount Graduate Student Support.....	14,419,846	14,780,000	15,818,000
Other Personnel Costs			
Amount of Support.....	11,422,678	11,708,200	12,530,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	600,000	615,000	638,000
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	22,032,700	22,584,000	24,169,000
Other Direct Research Costs*	12,977,545	13,302,000	14,236,990
Indirect Costs.....	28,359,674	29,049,000	31,111,000
TOTAL.....	\$106,975,530	\$109,650,000	\$117,330,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Engineering

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$123,967,492	\$136,209,000	\$157,286,000
Applied Research.....	26,260,633	25,366,000	26,784,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	150,228,125	161,575,000	184,070,000
(Conduct of R&D Performed by Colleges and Universities.)...	(142,793,947)	(155,336,000)	(176,867,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	400,000	900,000	1,400,000
Subtotal, R&D Facilities & Major Equipment.....	400,000	900,000	1,400,000
Total, Support of R&D.....	150,628,125	162,475,000	185,470,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$150,628,125	\$162,475,000	\$185,470,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	5,324	5,964	6,326
Dollars Requested (Total).....	\$3,627,563,934	\$2,331,720,000	\$2,350,950,000
Action Summary			
Number of Awards.....	1,985	2,011	2,108
Dollars Obligated (Total).....	150,628,125	162,475,000	185,470,000
Average Award Size.....	75,883	80,777	84,784
Dollar Distribution by Performer			
Universities.....	143,133,947	155,676,000	178,147,000
Industry.....	3,419,995	3,042,000	2,989,000
Federal Agencies.....	491,634	412,000	488,000
Other.....	3,522,549	3,345,000	3,926,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	2,630	2,736	3,047
Amount of Scientist Support.....	27,439,142	29,310,000	33,310,000
Number of Years of Scientist Support.....	562	599	683
Postdoctoral Support			
Number of Postdoctorals Supported.....	232	246	279
Amount Postdoctoral Support.....	3,285,683	3,455,000	3,890,000
Graduate Students			
Number of Graduate Students Supported.....	2,449	2,638	2,991
Amount Graduate Student Support.....	26,274,925	27,637,000	30,952,000
Other Personnel Costs			
Amount of Support.....	14,014,537	15,376,000	17,769,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	400,000	900,000	1,400,000
Other Equipment and Instrumentation.....	16,801,568	18,652,000	21,574,000
Other Direct Research Costs*	23,324,231	25,191,000	28,837,000
Indirect Costs.....	39,088,039	41,954,000	47,742,000
TOTAL.....	\$150,628,125	\$162,475,000	\$185,470,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Engineering Science in Chemical, Biochemical and Thermal Engineering

Research and Development Special Analysis

	Actual FY 1965	Estimate FY 1966	Estimate FY 1967
Support of R&D			
Conduct of Research			
Basic Research.....	\$25,882,437	\$25,885,000	\$26,798,000
Applied Research.....	3,295,191	3,295,000	3,412,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	29,177,628	29,180,000	30,210,000
(Conduct of R&D Performed by Colleges and Universities.)...	(29,621,206)	(28,624,000)	(29,634,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	29,177,628	29,180,000	30,210,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$29,177,628	\$29,180,000	\$30,210,000

Quantitative Data Table

	Actual FY 1965	Estimate FY 1966	Estimate FY 1967
Proposal Summary			
Number of Proposals Received.....	1,327	1,458	1,470
Dollars Requested (Total).....	\$179,711,437	\$197,640,200	\$199,500,200
Action Summary			
Number of Awards.....	534	534	545
Dollars Obligated (Total).....	29,177,628	29,180,000	30,210,000
Average Award Size.....	\$4,640	\$4,640	\$5,431
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	28,621,206	29,624,000	29,534,000
Industry.....	118,869	119,000	123,000
Federal Agencies.....	25,780	0	0
Other.....	412,773	437,000	453,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	573	573	583
Amount of Scientist Support.....	4,643,945	4,644,000	4,908,000
Number of Years of Scientist Support.....	95	95	98
Postdoctoral Support			
Number of Postdoctorals Supported.....	43	43	45
Amount Postdoctoral Support.....	550,654	551,000	570,000
Graduate Students			
Number of Graduate Students Supported.....	600	600	620
Amount Graduate Student Support.....	6,199,651	6,200,000	6,419,000
Other Personnel Costs			
Amount of Support.....	2,334,699	2,335,000	2,417,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	3,733,613	3,734,000	3,866,000
Other Direct Research Costs*	4,309,804	4,310,000	4,462,000
Indirect Costs.....	7,405,262	7,406,000	7,668,000
TOTAL.....	\$29,177,628	\$29,180,000	\$30,210,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Engineering Science in Mechanics, Structures, and Materials EngineeringResearch and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$20,673,062	\$21,019,000	\$23,298,000
Applied Research.....	2,636,671	2,681,000	2,972,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	23,309,733	23,700,000	26,270,000
(Conduct of R&D Performed by Colleges and Universities.)..	(22,526,761)	(22,904,000)	(25,388,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	23,309,733	23,700,000	26,270,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$23,309,733	\$23,700,000	\$26,270,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,084	1,188	1,286
Dollars Requested (Total).....	\$155,705,788	\$170,640,000	\$183,750,000
Action Summary			
Number of Awards.....	365	365	400
Dollars Obligated (Total).....	23,309,733	23,700,000	26,270,000
Average Award Size.....	63,862	64,932	65,675
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	22,526,761	22,904,000	25,388,000
Industry.....	536,060	545,000	604,000
Federal Agencies.....	65,838	0	0
Other.....	181,074	251,000	278,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	400	406	450
Amount of Scientist Support.....	4,611,473	4,689,000	5,197,000
Number of Years of Scientist Support.....	92	94	104
Postdoctoral Support			
Number of Postdoctorals Supported.....	67	68	76
Amount Postdoctoral Support.....	582,846	593,000	657,000
Graduate Students			
Number of Graduate Students Supported.....	400	407	451
Amount Graduate Student Support.....	4,423,398	4,497,300	4,985,000
Other Personnel Costs			
Amount of Support.....	2,405,632	2,446,000	2,711,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	2,179,074	2,216,000	2,456,000
Other Direct Research Costs*	2,870,547	2,919,000	3,235,000
Indirect Costs.....	6,236,762	6,340,000	7,029,000
TOTAL.....	\$23,309,733	\$23,700,000	\$26,270,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Engineering Science in Electrical, Communications and Systems EngineeringResearch and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$22,875,284	\$22,782,000	\$23,287,000
Applied Research.....	2,930,002	2,918,000	2,983,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	25,805,286	25,700,000	26,270,000
(Conduct of R&D Performed by Colleges and Universities.)..	(25,652,154)	(25,547,000)	(26,114,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	25,805,286	25,700,000	26,270,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$25,805,286	\$25,700,000	\$26,270,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,193	1,296	1,313
Dollars Requested (Total).....	\$133,523,247	\$144,720,000	\$147,000,000
Action Summary			
Number of Awards.....	393	390	395
Dollars Obligated (Total).....	25,805,286	25,700,000	26,270,000
Average Award Size.....	65,662	65,897	66,506
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	25,652,154	25,547,000	26,114,000
Industry.....	47,648	47,000	49,000
Federal Agencies.....	5,116	0	0
Other.....	100,368	106,000	107,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	476	474	484
Amount of Scientist Support.....	5,030,302	5,010,000	5,121,000
Number of Years of Scientist Support.....	97	97	99
Postdoctoral Support			
Number of Postdoctorals Supported.....	24	24	24
Amount Postdoctoral Support.....	243,703	243,000	248,000
Graduate Students			
Number of Graduate Students Supported.....	499	497	508
Amount Graduate Student Support.....	4,733,750	4,714,000	4,819,000
Other Personnel Costs			
Amount of Support.....	2,264,026	2,255,000	2,305,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	3,257,619	3,244,000	3,316,000
Other Direct Research Costs*	3,298,900	3,285,000	3,358,000
Indirect Costs.....	6,976,986	6,949,000	7,103,000
TOTAL.....	\$25,805,286	\$25,700,000	\$26,270,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Science Base Development in Design Manufacturing and Computer Engineering

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$13,664,303	\$15,147,000	\$18,420,000
Applied Research.....	3,800,000	3,553,000	3,250,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	17,464,303	18,700,000	21,670,000
(Conduct of R&D Performed by Colleges and Universities.)..	(16,194,091)	(17,340,000)	(20,394,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	17,464,303	18,700,000	21,670,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$ 17,464,303	\$18,700,000	\$21,670,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	540	702	819
Dollars Requested (Total).....	\$94,606,195	\$120,960,000	\$140,700,000
Action Summary			
Number of Awards.....	188	201	233
Dollars Obligated (Total).....	17,464,303	18,700,000	21,670,000
Average Award Size.....	92,895	92,895	92,895
Average Award Duration (Years).....	1.3	1.3	1.3
Dollar Distribution by Performer			
Universities.....	16,194,091	17,340,000	20,394,000
Industry.....	379,350	408,000	471,000
Federal Agencies.....	102,117	109,000	127,000
Other.....	788,745	843,000	978,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	253	271	314
Amount of Scientist Support.....	3,299,402	3,533,000	4,094,000
Number of Years of Scientist Support.....	50	54	62
Postdoctoral Support			
Number of Postdoctorals Supported.....	12	13	15
Amount Postdoctoral Support.....	116,131	124,000	144,000
Graduate Students			
Number of Graduate Students Supported.....	272	291	338
Amount Graduate Student Support.....	3,569,750	3,922,000	4,429,000
Other Personnel Costs			
Amount of Support.....	1,555,673	1,666,000	1,930,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	2,000,990	2,143,000	2,483,000
Other Direct Research Costs*	2,665,879	2,855,000	3,308,000
Indirect Costs.....	4,256,478	4,557,000	5,282,000
TOTAL.....	\$ 17,464,303	\$18,700,000	\$21,670,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Fundamental Research for Emerging and Critical Engineering Systems

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	528,384,610	529,076,000	534,583,300
Applied Research.....	6,876,297	7,119,000	9,467,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	34,960,907	36,195,000	43,050,300
(Conduct of R&D Performed by Colleges and Universities.)..	(31,701,981)	(32,821,000)	(39,537,300)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	34,960,907	36,195,000	43,050,300
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	34,960,907	36,195,000	43,050,300

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	903	1,188	1,313
Dollars Requested (Total).....	\$142,201,591	\$183,600,000	\$215,300,000
Action Summary			
Number of Awards.....	455	471	560
Dollars Obligated (Total).....	34,960,907	36,195,000	43,050,000
Average Award Size.....	76,837	76,837	76,837
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	31,701,981	32,821,000	39,037,000
Industry.....	1,414,860	1,465,000	1,742,000
Federal Agencies.....	292,763	303,000	361,000
Other.....	1,551,283	1,606,000	1,910,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	634	657	781
Amount of Scientist Support.....	6,695,843	6,932,000	8,245,000
Number of Years of Scientist Support.....	264	170	202
Postdoctoral Support			
Number of Postdoctorals Supported.....	55	57	68
Amount Postdoctoral Support.....	841,907	872,000	1,037,000
Graduate Students			
Number of Graduate Students Supported.....	473	490	582
Amount Graduate Student Support.....	9,175,294	9,338,000	10,373,000
Other Personnel Costs			
Amount of Support.....	3,248,739	3,467,000	4,124,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	3,824,303	3,960,000	4,709,000
Other Direct Research Costs*	9,944,263	6,194,000	7,320,000
Indirect Costs.....	9,130,338	9,452,000	11,242,000
TOTAL.....	34,960,907	36,195,000	43,050,300

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Cross-Disciplinary Research**Research and Development Special Analysis**

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$12,787,796	\$22,300,000	\$30,900,000
Applied Research.....	6,722,472	5,800,000	5,700,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	19,510,268	28,100,000	36,600,000
(Conduct of R&D Performed by Colleges and Universities)...	(19,097,754)	(28,100,000)	(36,600,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	400,000	900,000	1,400,000
Subtotal, R&D Facilities & Major Equipment	400,000	900,000	1,400,000
Total, Support of R&D.....	19,910,268	29,000,000	38,000,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$19,910,268	\$29,000,000	\$38,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	277	132	126
Dollars Requested (Total).....	\$2,921,815,676	\$1,514,160,000	\$1,470,000,000
Action Summary			
Number of Awards.....	50	50	54
Dollars Obligated (Total).....	19,910,268	29,000,000	38,000,000
Average Award Size.....	398,205	580,000	703,764
Average Award Duration (Years).....	0.9	1.2	1.0
Dollar Distribution by Performer			
Universities.....	18,497,754	28,440,000	37,900,000
Industry.....	923,208	460,000	0
Federal Agencies.....	0	0	0
Other.....	489,306	100,000	100,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	294	355	425
Amount of Scientist Support.....	3,158,157	4,502,000	5,845,000
Number of Years of Scientist Support.....	64	91	118
Postdoctoral Support			
Number of Postdoctorals Supported.....	31	41	52
Amount Postdoctoral Support.....	950,442	1,072,000	1,234,000
Graduate Students			
Number of Graduate Students Supported.....	205	352	492
Amount Graduate Student Support.....	2,173,082	3,046,000	3,927,000
Other Personnel Costs			
Amount of Support.....	2,105,767	3,207,000	4,278,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment*.....	0	0	0
Major Equipment.....	400,000	900,000	1,400,000
Other Equipment and Instrumentation.....	1,805,769	3,355,000	4,744,000
Other Direct Research Costs*	4,234,838	5,668,000	7,154,000
Indirect Costs.....	5,082,213	7,250,000	9,418,000
TOTAL.....	\$19,910,268	\$29,000,000	\$38,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Biological, Behavioral and Social Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$235,973,944	\$242,477,000	\$264,820,000
Applied Research.....	17,536,701	17,593,000	17,590,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	253,510,645	260,070,000	282,410,000
(Conduct of R&D Performed by Colleges and Universities, etc.)	(227,300,064)	(233,336,000)	(253,182,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	253,510,645	260,070,000	282,410,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$253,510,645	\$260,070,000	\$282,410,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	10,260	10,310	11,155
Dollars Requested (Total).....	\$2,144,993,386	\$2,192,220,000	\$2,574,376,000
Award Summary			
Number of Awards.....	3,897	3,879	3,879
Dollars Obligated (Total).....	253,510,645	260,070,000	282,410,000
Average Award Size.....	\$65,053	\$67,042	\$72,806
Dollar Distribution by Performer			
Universities.....	227,300,064	233,036,000	253,182,000
Industry.....	982,119	1,006,000	1,031,000
Federal Agencies.....	148,698	152,000	170,000
Other.....	25,079,764	25,874,000	27,927,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	3,229	3,219	3,227
Amount of Scientist Support.....	38,701,377	37,775,000	39,240,000
Number of Years of Scientist Support.....	862	859	855
Postdoctoral Support			
Number of Postdoctorals Supported.....	952	940	928
Amount Postdoctoral Support.....	15,965,359	16,286,000	16,741,000
Graduate Students			
Number of Graduate Students Supported.....	2,056	2,046	2,041
Amount Graduate Student Support.....	15,325,243	15,751,000	16,406,000
Other Personnel Costs			
Amount of Support.....	47,449,484	48,549,000	49,977,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	24,723,748	25,312,000	40,350,000
Other Direct Research Costs*	46,599,555	47,869,000	49,245,000
Indirect Costs.....	66,745,679	68,428,000	70,451,000
TOTAL.....	\$253,510,645	\$260,070,000	\$282,410,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Molecular Biosciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$57,241,139	\$58,230,000	\$63,400,000
Applied Research.....	3,685,673	3,700,000	3,700,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	60,926,812	61,930,000	67,100,000
(Conduct of R&D Performed by Colleges and Universities, etc.)	(56,601,008)	(57,533,000)	(62,336,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	60,926,812	61,930,000	67,100,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$60,926,812	\$61,930,000	\$67,100,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	2,126	2,161	2,341
Dollars Requested (Total).....	\$496,986,297	\$505,169,000	\$547,342,000
Action Summary			
Number of Awards.....	891	888	875
Dollars Obligated (Total).....	60,926,812	61,930,000	67,100,000
Average Award Size.....	68,380	69,748	76,723
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	\$6,601,008	\$7,333,000	\$6,336,000
Industry.....	121,854	124,000	134,000
Federal Agencies.....	121,854	124,000	134,000
Other.....	4,082,096	4,149,000	4,496,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	369	360	552
Amount of Scientist Support.....	5,261,921	5,365,000	6,326,000
Number of Years of Scientist Support.....	159	157	154
Postdoctoral Support			
Number of Postdoctorals Supported.....	380	374	369
Amount Postdoctoral Support.....	6,147,741	6,249,000	6,407,000
Graduate Students			
Number of Graduate Students Supported.....	419	413	406
Amount Graduate Student Support.....	3,512,772	3,571,000	3,661,000
Other Personnel Costs			
Amount of Support.....	9,278,340	9,431,000	9,570,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	11,776,702	11,971,000	16,171,000
Other Direct Research Costs*	8,743,292	8,887,000	9,012,000
Indirect Costs.....	15,206,044	15,456,000	15,753,000
TOTAL.....	\$60,926,812	\$61,930,000	\$67,100,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Cellular Biosciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$31,116,147	\$50,987,000	\$55,450,100
Applied Research.....	1,148,587	1,143,000	1,140,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	52,194,934	52,130,000	56,590,000
(Conduct of R&D Performed by Colleges and Universities)...	(49,134,139)	(47,960,000)	(52,263,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	52,194,934	52,130,000	56,590,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$52,194,934	\$52,130,000	\$56,590,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	2,319	2,308	2,105
Dollars Requested (Total).....	\$597,493,588	\$594,586,000	\$643,456,000
Action Summary			
Number of Awards.....	784	780	770
Dollars Allocated (Total).....	52,194,934	52,130,000	56,590,000
Average Award Size.....	\$6,818	\$6,818	\$7,499
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	48,194,139	47,960,000	50,453,000
Industry.....	209,540	209,000	276,000
Federal Agencies.....	0	0	0
Other.....	3,981,255	3,961,000	4,301,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	553	533	519
Amount of Scientist Support.....	5,889,524	5,861,000	5,939,000
Number of Years of Scientist Support.....	147	142	138
Postdoctoral Support			
Number of Postdoctorals Supported.....	253	244	237
Amount Postdoctoral Support.....	4,119,919	4,100,000	4,124,000
Graduate Students			
Number of Graduate Students Supported.....	782	768	759
Amount Graduate Student Support.....	2,465,421	2,453,000	2,486,000
Other Personnel Costs			
Amount of Support.....	11,504,084	11,423,000	11,516,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	3,562,175	3,570,000	7,610,000
Other Direct Research Costs*	10,083,142	10,034,000	10,094,000
Indirect Costs.....	14,760,669	14,689,000	14,784,000
TOTAL.....	\$52,194,934	\$52,130,000	\$56,590,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Biotic Systems and Resources**Research and Development Special Analysis**

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$52,230,610	\$55,120,000	\$60,610,000
Applied Research.....	5,890,208	5,900,000	5,900,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	58,120,818	61,020,000	66,510,000
(Conduct of R&D Performed by Colleges and Universities.)..	(50,681,353)	(53,209,000)	(57,997,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	58,120,818	61,020,000	66,510,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$58,120,818	\$61,020,000	\$66,510,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,844	1,936	2,110
Dollars Requested (Total).....	\$395,158,499	\$414,870,000	\$452,196,000
Award Summary			
Number of Awards.....	761	754	754
Dollars Obligated (Total).....	\$8,120,818	\$1,020,000	\$6,510,000
Average Award Size.....	76,374	80,957	88,243
Average Award Duration (Years).....	1.5	1.5	1.5
Dollar Distribution by Performer			
Universities.....	50,681,353	53,209,000	57,997,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	7,439,465	7,811,000	8,513,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	581	692	702
Amount of Scientist Support.....	7,463,524	7,836,000	8,267,000
Number of Years of Scientist Support.....	208	212	214
Postdoctoral Support			
Number of Postdoctorals Supported.....	160	163	165
Amount Postdoctoral Support.....	2,987,450	3,136,000	3,309,000
Graduate Students			
Number of Graduate Students Supported.....	338	393	398
Amount Graduate Student Support.....	3,151,331	3,288,000	3,468,000
Other Personnel Costs			
Amount of Support.....	13,194,436	13,853,000	14,536,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	4,806,591	5,046,000	7,636,000
Other Direct Research Costs*	13,219,868	13,879,000	14,642,000
Indirect Costs.....	13,317,618	13,982,000	14,652,000
TOTAL.....	\$58,120,818	\$61,020,000	\$66,510,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

*Behavioral and Neural Sciences**Research and Development Special Analysis*

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	543,493,564	544,790,000	547,970,000
Applied Research.....	884,864	900,000	900,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	44,378,428	45,690,000	46,870,000
(Conduct of R&D Performed by Colleges and Universities....)	(41,005,667)	(42,218,000)	(43,156,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	44,378,428	45,690,000	46,870,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	544,378,428	545,690,000	548,870,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	2,139	2,302	2,355
Dollars Requested (Total).....	540,634,331	545,657,000	546,211,000
Award Summary			
Number of Awards.....	798	798	797
Dollars Obligated (Total).....	44,378,428	45,690,000	46,870,000
Average Award Size.....	55,612	57,180	58,290
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	41,005,667	42,218,000	43,156,000
Industry.....	266,271	274,000	283,000
Federal Agencies.....	0	0	0
Other.....	3,106,490	3,198,000	3,421,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	389	607	665
Amount of Scientist Support.....	7,832,114	8,064,000	8,117,000
Number of Years of Scientist Support.....	190	190	183
Postdoctoral Support			
Number of Postdoctorals Supported.....	117	117	113
Amount Postdoctoral Support.....	1,916,264	1,973,000	1,986,000
Graduate Students			
Number of Graduate Students Supported.....	414	413	379
Amount Graduate Student Support.....	2,891,471	2,977,000	2,997,000
Other Personnel Costs			
Amount of Support.....	7,954,854	8,190,000	8,179,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	3,417,140	3,518,000	6,640,000
Other Direct Research Costs*	8,240,202	8,484,000	8,474,000
Indirect Costs.....	12,126,383	12,484,000	12,477,000
TOTAL.....	544,378,428	545,690,000	548,870,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Social and Economic Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$23,560,496	\$24,840,000	\$26,230,000
Applied Research.....	5,191,150	5,200,000	5,200,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	28,751,646	30,040,000	31,430,000
(Conduct of R&D Performed by Colleges and Universities....	(22,657,315)	(23,673,000)	(24,768,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	28,751,646	30,040,000	31,430,000
Education and Training	0	0	0
Collection of Information	0	0	0
TOTAL	\$28,751,646	\$30,040,000	\$31,430,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,385	1,447	1,514
Dollars Requested (Total).....	\$175,028,654	\$182,872,000	\$191,333,000
Action Summary			
Number of Awards.....	542	539	543
Dollars Obligated (Total).....	28,751,646	30,040,000	31,430,000
Average Award Size.....	\$53,047	\$55,700	\$57,928
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	22,657,315	23,673,000	24,768,000
Industry.....	142,858	149,000	156,000
Federal Agencies.....	0	0	0
Other.....	5,951,473	6,218,000	6,506,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	588	595	598
Amount of Scientist Support.....	7,296,413	7,623,000	7,976,000
Number of Years of Scientist Support.....	123	125	125
Postdoctoral Support			
Number of Postdoctorals Supported.....	34	34	35
Amount Postdoctoral Support.....	676,900	707,000	740,000
Graduate Students			
Number of Graduate Students Supported.....	338	342	344
Amount Graduate Student Support.....	2,146,363	2,284,000	2,390,000
Other Personnel Costs			
Amount of Support.....	4,286,226	4,478,000	4,686,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	534,780	559,000	585,000
Other Direct Research Costs*	5,228,118	5,462,000	5,715,000
Indirect Costs	8,542,846	8,927,000	9,338,000
TOTAL	\$28,751,646	\$30,040,000	\$31,430,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Information Science and Technology

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	88,211,789	58,510,000	911,240,000
Applied Research.....	738,219	750,000	750,000
Development.....	3	3	3
Subtotal, Conduct of R&D.....	8,948,007	9,260,000	11,910,000
(Conduct of R&D Performed by Colleges and Universities.)...	(8,160,582)	(8,445,000)	(10,982,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	8,948,007	9,260,000	11,910,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	88,948,007	89,260,000	911,910,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	247	256	329
Dollars Requested (Total).....	339,682,017	341,066,000	432,419,000
Action Summary			
Number of Awards.....	121	120	141
Dollars Obligated (Total).....	9,948,007	9,260,000	11,910,000
Average Award Size.....	73,950	76,908	84,599
Average Award Duration (years).....	1.3	1.3	1.3
Dollar Distribution by Performer			
Universities.....	8,160,582	8,445,000	10,982,000
Industry.....	241,596	250,000	322,000
Federal Agencies.....	26,844	28,000	36,000
Other.....	518,985	537,000	690,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	149	149	171
Amount of Scientist Support.....	1,957,881	2,326,000	2,414,000
Number of Years of Scientist Support.....	35	32	40
Postdoctoral Support			
Number of Postdoctorals Supported.....	8	8	9
Amount Postdoctoral Support.....	117,083	121,000	145,000
Graduate Students			
Number of Graduate Students Supported.....	117	117	134
Amount Graduate Student Support.....	1,137,985	1,179,000	1,404,000
Other Personnel Costs			
Amount of Support.....	1,231,544	1,274,000	1,490,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	626,360	648,000	1,700,000
Other Direct Research Costs*	1,084,933	1,123,000	1,300,000
Indirect Costs.....	2,792,319	2,890,000	3,447,000
TOTAL.....	88,948,007	89,260,000	911,910,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Astronomical, Atmospheric, Earth and Ocean Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	8327,024,054	8340,933,968	8360,640,000
Applied Research.....	5,250,289	5,483,000	5,956,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	332,274,343	346,416,968	366,596,000
(Conduct of R&D Performed by Colleges and Universities.)..	(219,401,602)	(226,820,968)	(243,395,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	2,819,100	1,644,300	1,679,300
Major Equipment.....	17,933,310	14,536,000	14,985,000
Subtotal, R&D Facilities & Major Equipment.....	20,752,410	16,180,300	16,614,300
Total, Support of R&D.....	353,026,753	362,596,968	383,210,300
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	353,026,753	362,596,968	383,210,300

Quantitative Data Table

	Actual	Estimate	Estimate
Proposal Summary			
Number of Proposals Received.....	4,089	4,270	4,639
Dollars Requested (Total).....	\$890,911,253	\$923,177,249	\$994,198,462
Action Summary			
Number of Awards.....	2,251	2,328	2,499
Dollars Obligated (Total).....	353,026,753	362,596,968	383,210,300
Average Award Size.....	154,831	155,753	153,356
Dollar Distribution by Performer			
Universities.....	219,401,602	226,820,968	243,395,000
Industry.....	1,137,547	1,144,000	1,196,000
Federal Agencies.....	736,350	799,000	1,031,000
Other.....	131,781,254	133,833,000	137,588,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	2,711	2,808	2,981
Amount of Scientist Support.....	38,131,346	39,762,500	42,174,000
Number of Years of Scientist Support.....	881	901	946
Postdoctoral Support			
Number of Postdoctorals Supported.....	529	549	576
Amount Postdoctoral Support.....	7,490,408	7,833,000	8,269,300
Graduate Students			
Number of Graduate Students Supported.....	1,805	1,878	2,313
Amount Graduate Student Support.....	16,945,843	17,454,000	18,989,000
Other Personnel Costs			
Amount of Support.....	82,087,227	83,467,500	87,263,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	2,819,100	1,644,000	1,629,000
Major Equipment.....	17,933,790	14,536,000	14,985,000
Other Equipment and Instrumentation.....	38,121,162	33,445,200	35,872,000
Other Direct Research Costs*	100,523,136	106,987,768	112,946,000
Indirect Costs.....	34,974,741	57,065,000	61,083,000
TOTAL.....	353,026,753	362,596,968	383,210,300

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Astronomical Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$71,777,808	\$74,425,000	\$74,860,000
Applied Research.....	0	0	0
Development.....	0	0	0
Subtotal, Conduct of R&D.....	71,777,808	74,425,000	74,860,000
(Conduct of R&D Performed by Colleges and Universities.)..	(26,336,628)	(26,700,000)	(26,800,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	500,000	1,000,000	1,000,000
Major Equipment.....	10,486,310	8,795,000	9,200,000
Subtotal, R&D Facilities & Major Equipment.....	10,986,310	9,795,000	10,200,000
Total, Support of R&D.....	82,764,118	84,220,000	85,060,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$82,764,118	\$84,220,000	\$85,060,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	470	493	513
Dollars Requested (Total).....	\$138,429,767	\$142,210,000	\$146,360,000
Action Summary			
Number of Awards.....	265	258	249
Dollars Obligated (Total).....	\$2,764,118	\$4,220,000	\$5,060,000
Average Award Size.....	\$10,430	\$16,357	\$20,321
Dollar Distribution by Performer			
Universities.....	26,336,628	26,700,000	26,800,000
Industry.....	31,000	32,300	32,000
Federal Agencies.....	77,200	78,000	78,000
Other.....	36,299,290	37,390,000	38,130,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	431	434	422
Amount of Scientist Support.....	7,882,701	8,206,500	8,337,000
Number of Years of Scientist Support.....	188	187	184
Postdoctoral Support			
Number of Postdoctorals Supported.....	112	114	110
Amount Postdoctoral Support.....	2,350,477	2,152,000	2,163,000
Graduate Students			
Number of Graduate Students Supported.....	238	242	232
Amount Graduate Student Support.....	2,014,201	2,111,000	2,107,000
Other Personnel Costs			
Amount of Support.....	29,489,466	30,499,500	30,915,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	500,000	1,000,000	1,000,000
Major Equipment.....	10,486,310	8,795,000	9,200,000
Other Equipment and Instrumentation.....	6,835,972	6,435,200	6,350,000
Other-Direct Research Costs*	16,080,971	17,179,800	16,868,000
Indirect Costs.....	7,424,020	7,841,000	7,920,000
TOTAL.....	\$82,764,118	\$84,220,000	\$85,060,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Astronomy Project Support

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	467	490	510
Dollars Requested (Total).....	\$82,900,000	\$85,600,000	\$89,000,000
Action Summary			
Number of Awards.....	262	293	246
Dollars Obligated (Total).....	27,234,351	27,610,000	27,700,000
Average Award Size.....	103,948	108,275	112,602
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	26,336,620	26,700,000	26,800,000
Industry.....	51,000	52,000	52,000
Federal Agencies.....	77,200	78,000	78,000
Other.....	769,523	780,000	770,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	322	327	315
Amount of Scientist Support.....	3,465,701	3,640,000	3,630,000
Number of Years of Scientist Support.....	79	80	77
Postdoctoral Support			
Number of Postdoctorals Supported.....	92	94	90
Amount Postdoctoral Support.....	1,618,477	1,700,000	1,700,000
Graduate Students			
Number of Graduate Students Supported.....	227	230	221
Amount Graduate Student Support.....	1,860,201	2,050,000	2,330,000
Other Personnel Costs			
Amount of Support.....	4,617,466	4,850,000	4,900,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	1,633,310	795,000	900,000
Other Equipment and Instrumentation.....	3,240,472	3,300,000	3,300,000
Other Direct Research Costs***			
	4,812,704	5,100,000	5,100,000
Indirect Costs.....			
	5,996,230	6,175,000	6,200,000
TOTAL.....	\$27,234,351	\$27,610,000	\$27,700,000
*Includes: Salaries, Supplies, and other costs for constructed equipment.			
**Does not include salaries, supplies, and other costs for constructed equipment.			
***Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.			

National Astronomy and Ionosphere Center

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1	1	1
Dollars Requested (Total).....	\$6,050,000	\$6,150,000	\$6,100,000
Action Summary			
Number of Awards.....	1	1	1
Dollars Obligated (Total).....	6,050,000	6,150,000	6,100,000
Average Award Size.....	6,050,000	6,150,000	6,100,000
Average Award Duration (Years).....	1.0	1.0	1.3
Dollar Distribution by Performer			
Universities.....	0	0	0
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	6,050,000	6,150,000	6,100,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	9	9	9
Amount of Scientist Support.....	327,000	348,500	337,000
Number of Years of Scientist Support.....	9	9	9
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	1,234,000	1,352,500	1,453,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation*.....	343,500	177,200	150,000
Other Direct Research Costs**.....	1,335,500	1,404,800	1,250,000
Indirect Costs.....	810,000	869,500	840,000
TOTAL.....	\$6,050,000	\$6,150,000	\$6,100,000

*Does not include salaries, supplies, and other constructed equipment.

**Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

National Optical Astronomy Observatories

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1	1	1
Dollars Requested (Total).....	\$22,826,767	\$23,800,000	\$24,200,000
Action Summary			
Number of Awards.....	1	1	1
Dollars Obligated (Total).....	\$22,826,767	\$23,800,000	\$24,200,000
Average Award Size.....	\$22,826,767	\$23,800,000	\$24,200,000
Average Award Duration (Years).....	1.0	1.0	1.3
Dollar Distribution by Performer			
Universities.....	0	0	0
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	\$22,826,767	\$23,800,000	\$24,200,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	65	63	63
Amount of Scientist Support.....	\$2,600,000	\$2,700,000	\$2,700,000
Number of Years of Scientist Support.....	65	63	63
Postdoctoral Support			
Number of Postdoctorals Supported.....	8	8	8
Amount Postdoctoral Support.....	\$182,000	\$192,000	\$198,000
Graduate Students			
Number of Graduate Students Supported.....	8	9	8
Amount Graduate Student Support.....	\$32,000	\$38,000	\$44,000
Other Personnel Costs			
Amount of Support.....	\$11,800,000	\$12,100,000	\$12,400,000
ASD Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	\$2,620,000	\$2,658,000	\$2,900,000
Other Direct Research Costs**.....	\$5,214,767	\$5,695,000	\$5,558,000
Indirect Costs***.....	\$378,000	\$417,000	\$330,000
TOTAL.....	\$22,826,767	\$23,800,000	\$24,200,000

*Does not include salaries, supplies, or other costs for constructed equipment.

**Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

***Management fee of the AURA consortium.

National Radio Astronomy Observatory

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1	1	1
Dollars Requested (Total).....	\$26,653,300	\$26,660,300	\$27,060,300
Action Summary			
Number of Awards.....	1	1	1
Dollars Obligated (Total).....	26,653,300	26,660,300	27,060,300
Average Award Size.....	26,653,300	26,660,300	27,060,300
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	0	0	0
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	26,653,300	26,660,300	27,060,300
Personnel			
Senior Scientists			
Number of Scientists Supported.....	35	35	35
Amount of Scientist Support.....	1,490,000	1,420,000	1,550,000
Number of Years of Scientist Support.....	35	35	35
Postdoctoral Support			
Number of Postdoctorals Supported.....	12	12	12
Amount Postdoctoral Support.....	250,300	260,300	265,300
Graduate Students			
Number of Graduate Students Supported.....	3	3	3
Amount Graduate Student Support.....	23,000	23,000	23,000
Other Personnel Costs			
Amount of Support.....	9,638,000	10,197,000	10,162,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	500,000	1,000,000	1,000,000
Major Equipment.....	8,853,300	9,000,000	9,470,000
Other Equipment and Instrumentation.....	632,000	100,000	100,000
Other Direct Research Costs**.....	4,719,000	4,980,000	4,960,000
Indirect Costs***.....	150,000	380,000	100,000
TOTAL.....	\$26,653,300	\$26,660,300	\$27,060,300

*Does not include salaries, supplies, and other cost for constructed equipment.

**Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel Operation, Maintenance, Utilities.

***Management fee of the AUI Consortium.

Atmospheric Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$87,364,546	\$89,740,000	\$93,535,000
Applied Research.....	1,134,111	1,159,000	1,201,200
Development.....	0	0	0
Subtotal, Conduct of R&D.....	88,498,657	90,899,000	94,736,200
(Conduct of R&D Performed by Colleges and Universities...)	(44,957,176)	(46,741,000)	(48,385,200)
R&D Facilities			
Land, Building and Fixed Equipment.....	2,200,000	644,000	629,000
Major Equipment.....	4,365,000	5,241,000	5,285,000
Subtotal, R&D Facilities & Major Equipment.....	6,565,000	5,885,000	5,914,000
Total, Support of R&D.....	95,063,657	96,780,000	100,650,200
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$95,063,657	\$96,780,000	\$100,650,200

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	807	838	870
Dollars Requested (Total).....	\$162,554,366	\$166,924,000	\$173,305,200
Action Summary			
Number of Awards.....	549	570	591
Dollars Obligated (Total).....	95,063,657	96,780,000	100,650,000
Average Award Size.....	173,158	169,789	170,135
Dollar Distribution by Performer			
Universities.....	44,957,176	46,741,000	48,385,000
Industry.....	691,000	717,000	745,000
Federal Agencies.....	145,000	150,000	156,000
Other.....	49,270,481	49,172,000	51,344,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	878	904	933
Amount of Scientist Support.....	14,383,132	14,431,000	15,225,000
Number of Years of Scientist Support.....	320	326	333
Postdoctoral Support			
Number of Postdoctorals Supported.....	214	222	230
Amount Postdoctoral Support.....	2,777,843	2,895,000	3,013,000
Graduate Students			
Number of Graduate Students Supported.....	524	538	559
Amount Graduate Student Support.....	5,643,785	5,775,000	5,999,000
Other Personnel Costs			
Amount of Support.....	22,765,348	22,249,000	23,264,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	2,200,000	644,000	629,000
Major Equipment.....	4,365,000	5,241,000	5,285,000
Other Equipment and Instrumentation.....	9,369,940	10,244,000	11,021,000
Other Direct Research Costs*	17,305,285	18,037,000	18,476,000
Indirect Costs.....	16,853,324	17,264,000	17,938,000
TOTAL.....	\$95,063,657	\$96,780,000	\$100,650,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Atmospheric Sciences Project Support

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	901	931	863
Dollars Requested (Total).....	\$112,051,310	\$116,275,000	\$120,772,000
Action Summary			
Number of Awards.....	544	565	586
Dollars Obligated (Total).....	47,619,871	49,415,000	51,326,000
Average Award Size.....	87,537	87,460	87,587
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	42,486,946	44,389,000	45,734,000
Industry.....	491,000	717,000	745,000
Federal Agencies.....	149,000	155,000	156,000
Other.....	4,298,925	4,458,000	4,631,000
Personnel			
Senior Scientists	740	768	798
Number of Scientist Supportes.....	6,822,132	7,279,000	7,353,000
Amount of Scientist Support.....	190	197	205
Number of Years of Scientist Support.....			
Postdoctoral Support	193	200	208
Number of Postdoctorals Supported.....	2,152,843	2,234,000	2,320,000
Amount Postdoctoral Support.....			
Graduate Students	515	534	555
Number of Graduate Students Supported.....	5,506,785	5,714,000	5,935,000
Amount Graduate Student Support.....			
Other Personnel Costs	3,985,348	4,115,000	4,274,000
Amount of Support.....			
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	7,573,210	7,349,000	7,624,000
Other Direct Research Costs*	9,956,285	10,332,000	10,731,000
Indirect Costs.....	12,143,268	12,601,000	13,189,000
TOTAL.....	347,619,871	349,415,000	351,326,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

National Center for Atmospheric Research

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1	1	1
Dollars Requested (Total).....	\$43,503,056	\$43,135,000	\$43,191,000
Action Summary			
Number of Awards.....	1	1	1
Dollars Obligated (Total).....	\$43,503,056	\$43,135,000	\$43,191,000
Average Award Size.....	\$43,503,056	\$43,135,000	\$43,191,000
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	0	0	0
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	\$43,503,056	\$43,135,000	\$43,191,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	125	122	122
Amount of Scientist Support.....	\$6,661,000	\$6,708,000	\$7,043,000
Number of Years of Scientist Support.....	120	118	118
Postdoctoral Support			
Number of Postdoctorals Supported.....	20	21	21
Amount Postdoctoral Support.....	\$605,000	\$449,000	\$672,000
Graduate Students			
Number of Graduate Students Supported.....	9	4	4
Amount Graduate Student Support.....	\$137,000	\$1,000	\$4,000
Other Personnel Costs			
Amount of Support.....	\$18,160,000	\$17,447,300	\$18,319,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	\$1,600,000	0	0
Major Equipment.....	\$4,363,000	\$3,241,000	\$3,285,000
Other Equipment and Instrumentation.....	\$1,716,000	\$2,803,000	\$3,103,000
Other Direct Research Costs*			
.....	\$6,149,000	\$6,417,000	\$6,486,000
Indirect Costs			
.....	\$4,110,056	\$4,018,300	\$4,219,000
TOTAL	\$43,503,056	\$43,135,000	\$43,191,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Upper Atmospheric Research Facilities

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	5	5	5
Dollars Requested (Total).....	\$7,300,000	\$7,514,000	\$7,342,000
Action Summary			
Number of Awards.....	4	4	4
Dollars Obligated (Total).....	3,940,790	4,230,000	4,133,000
Average Award Size.....	985,183	1,057,500	1,033,250
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	2,470,230	2,652,300	2,591,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	1,470,560	1,578,000	1,542,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	13	14	14
Amount of Scientist Support.....	600,000	644,500	629,000
Number of Years of Scientist Support.....	10	11	10
Postdoctoral Support			
Number of Postdoctorals Supported.....	1	1	1
Amount Postdoctoral Support.....	20,000	21,000	21,000
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	640,000	687,000	611,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	600,000	644,000	619,000
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	280,730	301,000	294,000
Other Direct Research Costs*	1,200,000	1,289,000	1,259,000
Indirect Costs.....	900,000	849,000	630,000
TOTAL.....	\$5,940,730	\$6,230,000	\$6,133,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Earth Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$43,703,098	\$46,535,000	\$52,249,000
Applied Research.....	2,259,079	2,405,000	2,701,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	45,962,177	48,940,000	54,950,000
(Conduct of R&D Performed by Colleges and Universities.)..	(64,272,342)	(47,141,000)	(52,930,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	45,962,177	48,940,000	54,950,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$45,962,177	\$48,940,000	\$54,950,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,294	1,378	1,547
Dollars Requested (Total).....	\$186,437,259	\$198,516,000	\$222,495,000
Action Summary			
Number of Awards.....	652	694	778
Dollars Obligated (Total).....	45,962,177	48,940,000	54,950,000
Average Award Size.....	70,494	70,494	70,494
Average Award Duration (Years).....	1.5	1.5	1.5
Dollar Distribution by Performer			
Universities.....	44,272,342	47,141,000	52,930,000
Industry.....	40,000	43,000	48,000
Federal Agencies.....	0	0	0
Other.....	1,649,635	1,756,000	1,972,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	662	705	791
Amount of Scientist Support.....	\$,211,780	\$,549,000	\$,231,000
Number of Years of Scientist Support.....	112	119	134
Postdoctoral Support			
Number of Postdoctorals Supported.....	90	96	108
Amount Postdoctoral Support.....	1,225,376	1,305,000	1,465,000
Graduate Students			
Number of Graduate Students Supported.....	425	665	747
Amount Graduate Student Support.....	\$,571,758	\$,933,000	\$,661,000
Other Personnel Costs			
Amount of Support.....	2,375,216	2,529,000	2,840,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	5,476,754	5,832,000	6,548,000
Other Direct Research Costs*	15,489,906	16,493,000	18,519,000
Indirect Costs.....	10,611,387	11,299,000	12,686,000
TOTAL.....	\$45,962,177	\$48,940,000	\$54,950,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Ocean Sciences

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$116,685,446	\$122,214,968	\$131,629,000
Applied Research.....	1,388,946	1,422,000	1,931,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	118,074,392	123,636,968	133,560,000
(Conduct of R&D Performed by Colleges and Universities)...	(96,890,790)	(98,788,968)	(107,160,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	119,100	0	0
Major Equipment.....	3,082,700	500,000	500,000
Subtotal, R&D Facilities & Major Equipment.....	3,201,800	500,000	500,000
Total, Support of R&D.....	121,276,192	124,136,968	133,660,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$121,276,192	\$124,136,968	\$133,660,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,393	1,420	1,570
Dollars Requested (Total).....	\$365,909,861	\$375,395,249	\$409,744,462
Action Summary			
Number of Awards.....	717	734	803
Dollars Obligated (Total).....	121,276,192	124,136,968	133,660,000
Average Award Size.....	169,143	169,163	166,373
Dollar Distribution by Performer			
Universities.....	96,890,790	98,788,968	107,160,000
Industry.....	167,279	172,000	191,000
Federal Agencies.....	265,000	271,000	297,000
Other.....	23,932,423	24,805,000	26,012,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	655	674	740
Amount of Scientist Support.....	9,997,603	10,553,000	11,914,000
Number of Years of Scientist Support.....	238	244	269
Postdoctoral Support			
Number of Postdoctorals Supported.....	105	108	119
Amount Postdoctoral Support.....	1,320,517	1,358,000	1,498,000
Graduate Students			
Number of Graduate Students Supported.....	367	377	418
Amount Graduate Student Support.....	3,339,286	3,432,000	3,901,000
Other Personnel Costs			
Amount of Support.....	26,498,564	27,364,000	29,174,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	119,100	0	0
Major Equipment.....	3,082,480	500,000	500,000
Other Equipment and Instrumentation.....	10,366,196	10,536,000	11,337,000
Other Direct Research Costs*	48,105,445	51,487,968	55,128,000
Indirect Costs.....	18,446,601	18,906,000	20,708,000
TOTAL.....	\$121,276,192	\$124,136,968	\$133,660,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Ocean Sciences Research Support

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,175	1,208	1,338
Dollars Requested (Total).....	\$265,803,580	\$273,209,000	\$302,746,000
Action Summary			
Number of Awards.....	549	564	625
Dollars Obligated (Total).....	\$8,330,932	\$9,956,000	\$6,438,000
Average Award Size.....	106,249	106,249	106,249
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	\$6,205,803	\$8,491,000	\$6,815,000
Industry.....	167,279	172,000	191,000
Federal Agencies.....	200,000	208,000	228,000
Other.....	1,057,850	1,087,000	1,204,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	544	559	620
Amount of Scientist Support.....	7,790,168	8,207,000	8,873,000
Number of Years of Scientist Support.....	204	210	232
Postdoctoral Support			
Number of Postdoctorals Supported.....	97	100	110
Amount Postdoctoral Support.....	1,233,965	1,268,000	1,405,000
Graduate Students			
Number of Graduate Students Supported.....	362	372	412
Amount Graduate Student Support.....	3,298,555	3,390,000	3,757,000
Other Personnel Costs			
Amount of Support.....	7,893,371	9,113,000	8,990,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	4,232,606	4,351,000	4,921,000
Other Direct Research Costs*	19,460,179	20,002,000	22,163,000
Indirect Costs	14,422,088	14,825,000	16,427,000
TOTAL	\$58,330,932	\$59,956,000	\$66,438,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Oceanographic Centers and Facilities

Quantitative Data Table

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	173	174	183
Dollars Requested (Total).....	\$59,186,281	\$59,372,000	\$58,257,000
Action Summary			
Number of Awards.....	142	142	150
Dollars Obligated (Total).....	35,212,619	35,330,968	37,172,000
Average Award Size.....	247,976	247,976	247,976
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	35,147,619	35,265,968	37,103,000
Industry.....	0	0	0
Federal Agencies.....	65,000	65,000	69,000
Other.....	0	0	0
Personnel			
Senior Scientists			
Number of Scientists Supported.....	4	4	4
Amount of Scientist Support.....	30,596	31,000	32,000
Number of Years of Scientist Support.....	2	2	2
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	14,513,578	14,562,000	15,321,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	119,100	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	4,633,590	4,649,000	4,591,000
Other Direct Research Costs*	13,051,275	13,214,968	13,904,000
Indirect Costs	2,864,480	2,874,000	3,024,000
TOTAL	\$35,212,619	\$35,330,968	\$37,172,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Ocean Drilling Program

Quantitative Data Table

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	45	47	49
Dollars Requested (Total).....	\$45,000,000	\$46,814,249	\$48,761,462
Action Summary			
Number of Awards.....	26	27	28
Dollars Obligated (Total).....	27,731,941	28,850,000	30,050,000
Average Award Size.....	1,066,613	1,066,613	1,066,613
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	4,837,368	5,032,000	5,242,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	22,894,573	23,818,000	24,808,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	107	111	116
Amount of Scientist Support.....	2,177,339	2,515,000	2,609,000
Number of Years of Scientist Support.....	32	33	35
Postdoctoral Support			
Number of Postdoctorals Supported.....	8	8	9
Amount Postdoctoral Support.....	86,352	90,000	93,300
Graduate Students			
Number of Graduate Students Supported.....	3	5	5
Amount Graduate Student Support.....	40,731	42,000	44,000
Other Personnel Costs			
Amount of Support.....	4,091,615	4,689,000	4,863,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	3,082,480	500,000	500,000
Other Equipment and Instrumentation.....	1,500,000	1,536,000	1,635,000
Other Direct Research Costs*.....	13,593,991	18,271,000	19,039,000
Indirect Costs.....	1,160,333	1,207,000	1,257,000
TOTAL.....	\$27,731,941	\$28,850,000	\$30,050,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Arctic Research Program

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$7,493,156	\$8,019,000	\$8,367,000
Applied Research.....	468,153	501,000	523,200
Development.....	0	0	0
Subtotal, Conduct of R&D.....	7,961,309	8,520,000	8,890,200
(Conduct of R&D Performed by Colleges and Universities)...	(6,944,666)	(7,450,000)	(8,120,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	7,961,309	8,520,000	8,890,200
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$7,961,309	\$8,520,000	\$8,890,200

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	125	134	140
Dollars Requested (Total).....	\$37,300,000	\$40,132,000	\$41,874,000
Action Summary			
Number of Awards.....	68	73	76
Dollars Obligated (Total).....	7,961,309	8,520,000	8,890,200
Average Award Size.....	117,078	117,078	117,378
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	6,944,666	7,450,000	7,120,000
Industry.....	158,268	160,000	160,000
Federal Agencies.....	249,150	300,000	300,000
Other.....	609,225	610,000	110,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	85	91	95
Amount of Scientist Support.....	955,930	1,023,000	1,067,000
Number of Years of Scientist Support.....	23	25	26
Postdoctoral Support			
Number of Postdoctorals Supported.....	8	9	9
Amount Postdoctoral Support.....	116,695	125,000	130,000
Graduate Students			
Number of Graduate Students Supported.....	51	55	57
Amount Graduate Student Support.....	376,813	403,000	421,200
Other Personnel Costs			
Amount of Support.....	958,633	1,026,000	1,070,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	372,300	398,000	416,000
Other Direct Research Costs*	3,941,529	3,790,000	3,955,000
Indirect Costs.....	1,639,409	1,735,000	1,831,000
TOTAL.....	\$7,961,309	\$8,520,000	\$8,890,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Scientific, Technological and International Affairs

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$23,259,450	\$22,192,000	\$27,564,000
Applied Research.....	15,632,923	13,800,000	15,438,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	38,892,373	36,000,000	43,000,000
(Conduct of R&D Performed by Colleges and Universities.)..	(17,104,571)	(14,056,000)	(18,690,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	250,000
Subtotal, R&D Facilities & Major Equipment	0	0	250,000
Total, Support of R&D.....	38,892,373	36,000,000	43,250,000
Education and Training.....	0	0	0
Collection of Information.....	4,851,396	3,480,000	3,780,000
TOTAL.....	\$43,743,769	\$39,560,000	\$47,030,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	2,776	2,640	2,732
Dollars Requested (Total).....	\$148,294,097	\$132,500,000	\$140,950,000
Action Summary			
Number of Awards.....	995	847	960
Dollars Obligated (Total).....	43,743,769	39,560,000	47,030,000
Average Award Size.....	43,964	46,730	48,950
Dollar Distribution by Performer			
Universities.....	18,061,580	14,666,000	19,620,000
Industry.....	16,632,137	18,330,000	20,180,000
Federal Agencies.....	1,452,173	1,380,000	1,550,000
Other.....	7,597,879	5,184,000	5,680,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	760	735	827
Amount of Scientist Support.....	8,692,276	7,983,000	9,683,000
Number of Years of Scientist Support.....	194	171	226
Postdoctoral Support			
Number of Postdoctorals Supported.....	36	26	52
Amount Postdoctoral Support.....	728,035	533,000	1,033,000
Graduate Students			
Number of Graduate Students Supported.....	168	87	109
Amount Graduate Student Support.....	1,325,395	782,000	1,082,000
Other Personnel Costs			
Amount of Support.....	4,708,443	4,857,000	5,500,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	250,000
Other Equipment and Instrumentation.....	3,344,576	3,254,000	3,750,000
Other Direct Research Costs*	14,964,248	13,156,000	15,077,000
Indirect Costs.....	9,980,196	9,395,000	10,655,000
TOTAL.....	\$43,743,769	\$39,560,000	\$47,030,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Industrial Science and Technological Innovation

Research and Development Special Analysis

	Actual FY 1993	Estimate FY 1996	Estimate FY 1997
Support of R&D			
Conduct of Research			
Basic Research.....	\$6,409,321	\$7,742,000	\$8,404,000
Applied Research.....	6,670,925	8,030,000	9,746,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	13,080,246	15,800,000	17,150,000
(Conduct of R&D Performed by Colleges and Universities)...	(740,175)	(166,000)	0
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	13,080,246	15,800,000	17,150,000
Education and Training.....	0	0	0
Collection of Information.....	355,300	50,000	0
TOTAL.....	\$13,435,746	\$15,850,000	\$17,150,000

Quantitative Data Table

	Actual FY 1993	Estimate FY 1996	Estimate FY 1997
Proposal Summary			
Number of Proposals Received.....	1,079	1,080	1,100
Dollars Requested (Total).....	\$60,493,972	\$60,500,000	\$62,000,000
Action Summary			
Number of Awards.....	194	190	200
Dollars Obligated (Total).....	13,435,746	15,800,000	17,150,000
Average Award Size.....	69,256	83,121	85,750
Average Award Duration (Years).....	0.9	0.9*	0.9
Dollar Distribution by Performer			
Universities.....	740,175	166,000	0
Industry.....	12,520,613	15,650,000	17,150,000
Federal Agencies.....	0	0	0
Other.....	174,958	34,000	0
Personnel			
Senior Scientists			
Number of Scientists Supported.....	414	496	537
Amount of Scientist Support.....	3,306,537	3,963,000	4,288,000
Number of Years of Scientist Support.....	86	103	112
Postdoctoral Support			
Number of Postdoctorals Supported.....	15	8	8
Amount Postdoctoral Support.....	342,612	183,000	183,000
Graduate Students			
Number of Graduate Students Supported.....	47	10	10
Amount Graduate Student Support.....	407,103	87,000	87,000
Other Personnel Costs			
Amount of Support.....	1,793,672	2,382,000	2,910,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	376,201	444,000	480,000
Other Direct Research Costs*	2,614,596	3,171,000	3,337,000
Indirect Costs.....	4,595,025	5,420,000	5,600,000
TOTAL.....	\$13,435,746	\$15,850,000	\$17,150,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

International Cooperative Scientific Activities

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$8,993,702	\$7,800,000	\$9,110,000
Applied Research.....	3,428,539	3,040,000	3,580,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	12,422,241	10,840,000	12,690,000
(Conduct of R&D Performed by Colleges and Universities.)..	(6,920,000)	(6,000,000)	(7,350,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	12,422,241	10,840,000	12,690,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$12,422,241	\$10,840,000	\$12,690,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,250	1,250	1,300
Dollars Requested (Total).....	\$34,000,000	\$34,000,000	\$35,350,000
Action Summary			
Number of Awards.....	625	545	627
Dollars Obligated (Total).....	12,422,241	10,840,000	12,690,000
Average Award Size.....	19,876	19,876	20,191
Average Award Duration (Years).....	1.3	1.3	1.3
Dollar Distribution by Performer			
Universities.....	6,931,610	6,030,000	7,050,000
Industry.....	695,646	500,000	750,000
Federal Agencies.....	236,021	200,000	270,000
Other.....	4,558,962	4,110,000	4,590,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	58	53	58
Amount of Scientist Support.....	\$19,868	720,000	920,000
Number of Years of Scientist Support.....	20	18	20
Postdoctoral Support			
Number of Postdoctorals Supported.....	14	13	14
Amount Postdoctoral Support.....	273,289	270,000	270,000
Graduate Students			
Number of Graduate Students Supported.....	10	9	10
Amount Graduate Student Support.....	96,956	90,000	90,000
Other Personnel Costs			
Amount of Support.....	459,623	450,000	480,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	906,824	810,000	920,000
Other Direct Research Costs*	8,770,102	7,600,000	8,960,000
Indirect Costs.....	1,105,579	900,000	1,140,000
TOTAL.....	\$12,422,241	\$10,840,000	\$12,690,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Policy Research and Analysis

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$693,320	\$150,000	\$200,000
Applied Research.....	4,173,138	1,700,000	1,700,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	4,866,458	1,850,000	1,900,000
(Conduct of R&D Performed by Colleges and Universities.)...	(1,356,433)	(850,000)	(700,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Total, Support of R&D.....	4,866,458	1,850,000	1,900,000
Education and Training.....	0	0	0
Collection of Information.....	279,712	90,000	70,000
TOTAL.....	\$5,146,170	\$1,940,000	\$1,970,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	120	75	75
Dollars Requested (Total).....	\$13,113,613	\$5,500,000	\$5,500,000
Action Summary			
Number of Awards.....	67	30	30
Dollars Obligated (Total).....	\$,146,170	1,940,000	1,990,000
Average Award Size.....	76,809	64,667	66,333
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	1,556,435	650,000	700,000
Industry.....	1,970,144	800,000	600,000
Federal Agencies.....	26,000	120,000	120,000
Other.....	1,393,591	370,000	370,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	120	54	55
Amount of Scientist Support.....	1,820,000	630,000	590,000
Number of Years of Scientist Support.....	40	15	16
Postdoctoral Support			
Number of Postdoctorals Supported.....	5	3	3
Amount Postdoctoral Support.....	50,000	23,000	20,000
Graduate Students			
Number of Graduate Students Supported.....	60	25	25
Amount Graduate Student Support.....	350,000	150,000	150,000
Other Personnel Costs			
Amount of Support.....	800,000	240,000	240,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	0	0	0
Other Direct Research Costs*	976,170	300,000	300,000
Indirect Costs.....	1,350,000	600,000	600,000
TOTAL.....	\$5,146,170	\$1,940,000	\$1,970,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Science Resources Studies

Research and Development Special Analysis

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research	50	90	90
Basic Research	603,568	600,000	650,000
Applied Research	0	0	0
Development	0	0	650,000
Subtotal, Conduct of R&D	603,568	600,000	650,000
(Conduct of R&D Performed by Colleges and Universities)...	(250,851)	(250,300)	(300,000)
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D	603,568	600,000	650,000
Education and Training	0	0	0
Collection of Information	3,536,112	3,340,000	3,590,000
TOTAL	84,139,680	83,940,000	84,240,000

Quantitative Data Table

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received	71	75	75
Dollars Requested (Total)	812,160,800	812,300,000	813,000,000
Action Summary			
Number of Awards	38	38	38
Dollars Obligated (Total)	4,139,680	3,940,000	4,240,000
Average Award Size	108,939	103,444	111,579
Average Award Duration (Years)	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities	863,701	830,000	880,000
Industry	1,445,734	1,380,000	1,480,000
Federal Agencies	1,130,849	1,060,000	1,160,000
Other	699,396	670,000	720,000
Personnel			
Senior Scientists			
Number of Scientists Supported	73	70	75
Amount of Scientist Support	791,112	750,000	825,000
Number of Years of Scientist Support	21	18	21
Postdoctoral Support			
Number of Postdoctorals Supported	0	0	0
Amount Postdoctoral Support	0	0	0
Graduate Students			
Number of Graduate Students Supported	9	8	8
Amount Graduate Student Support	75,774	75,000	75,000
Other Personnel Costs			
Amount of Support	899,809	865,000	920,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment	0	0	0
Major Equipment	0	0	0
Other Equipment and Instrumentation	0	0	0
Other Direct Research Costs*	1,292,188	1,225,000	1,320,000
Indirect Costs	1,080,798	1,025,000	1,100,000
TOTAL	84,139,680	83,940,000	84,240,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Research Initiation and Improvement**Research and Development Special Analysis**

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$7,163,107	\$6,500,000	\$9,850,300
Applied Research.....	756,753	490,000	790,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	7,919,860	6,990,000	10,640,300
(Conduct of R&D Performed by Colleges and Universities)...	(7,637,110)	(6,990,000)	(10,640,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	250,000
Subtotal, R&D Facilities & Major Equipment	0	0	250,000
Total, Support of R&D.....	7,919,860	6,990,000	10,890,000
Education and Training.....	0	0	0
Collection of Information.....	680,072	0	100,000
TOTAL.....	\$8,599,932	\$6,990,000	\$10,990,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	256	180	182
Dollars Requested (Total).....	\$28,525,712	\$20,000,000	\$25,000,000
Action Summary			
Number of Awards.....	71	45	65
Dollars Obligated (Total).....	8,599,932	6,990,000	10,990,000
Average Award Size.....	121,126	133,333	169,077
Average Award Duration (Years).....	2.3	2.0	2.3
Dollar Distribution by Performer			
Universities.....	7,969,659	6,990,000	10,990,000
Industry.....	0	0	0
Federal Agencies.....	59,301	0	0
Other.....	570,972	0	0
Personnel			
Senior Scientists			
Number of Scientists Supported.....	95	62	102
Amount of Scientist Support.....	1,954,759	1,520,000	3,070,000
Number of Years of Scientist Support.....	27	17	57
Postdoctoral Support			
Number of Postdoctorals Supported.....	2	2	27
Amount Postdoctoral Support.....	62,134	60,000	560,000
Graduate Students			
Number of Graduate Students Supported.....	43	36	36
Amount Graduate Student Support.....	406,162	380,000	690,000
Other Personnel Costs			
Amount of Support.....	955,340	720,000	970,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	250,000
Other Equipment and Instrumentation.....	2,081,551	2,000,000	2,350,000
Other Direct Research Costs*	1,311,192	860,000	1,160,000
Indirect Costs.....	1,048,794	1,450,000	1,930,000
TOTAL.....	\$8,599,932	\$6,990,000	\$10,990,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Advanced Scientific Computing

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$22,768,961	\$24,877,000	\$29,498,000
Applied Research.....	20,700	23,000	27,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	22,789,661	24,900,000	29,525,000
(Conduct of R&D Performed by Colleges and Universities.)...	(19,744,236)	(21,573,000)	(25,580,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	6,413,765	7,008,000	8,309,000
Major Equipment.....	12,192,227	13,322,000	15,796,000
Subtotal, R&D Facilities & Major Equipment.....	18,605,992	20,330,000	24,105,000
Total, Support of R&D.....	41,395,653	45,230,000	53,630,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$41,395,653	\$45,230,000	\$53,630,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	85	140	170
Dollars Requested (Total).....	\$997,781,507	\$90,000,000	\$101,000,000
Action Summary			
Number of Awards.....	45	60	75
Dollars Obligated (Total).....	41,395,653	45,230,000	53,630,000
Average Award Size.....	919,903	753,833	766,143
Average Award Duration (Years).....	1.1	1.1	1.1
Dollar Distribution by Performer			
Universities.....	19,744,236	21,573,000	25,580,000
Industry.....	9,174,987	10,025,000	11,887,000
Federal Agencies.....	3,008,200	3,287,000	3,897,000
Other.....	9,468,230	10,345,000	12,266,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	17	19	22
Amount of Scientist Support.....	256,500	280,000	332,000
Number of Years of Scientist Support.....	3	3	4
Postdoctoral Support			
Number of Postdoctorals Supported.....	4	12	13
Amount Postdoctoral Support.....	72,741	79,000	94,000
Graduate Students			
Number of Graduate Students Supported.....	3	22	23
Amount Graduate Student Support.....	99,991	109,200	130,000
Other Personnel Costs			
Amount of Support.....	1,757,659	1,920,000	2,277,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	6,413,765	7,008,000	8,309,000
Major Equipment.....	12,192,227	13,322,000	15,796,000
Other Equipment and Instrumentation.....	2,983,748	3,238,000	3,840,000
Other Direct Research Costs*	15,684,693	17,138,000	20,320,000
Indirect Costs.....	1,934,309	2,136,000	2,532,000
TOTAL.....	\$41,395,653	\$45,230,000	\$53,630,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Program Development and Management

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	960,295,165	961,117,500	965,910,000
Applied Research.....	4,079,271	3,770,000	3,978,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	64,124,436	64,887,500	69,888,000
R&D Facilities			
Land, Building and Fixed Equipment.....	863,415	942,500	1,014,000
Major Equipment.....	2,590,245	2,469,000	2,808,000
Subtotal, R&D Facilities & Major Equipment.....	3,453,660	3,407,500	3,822,000
Total, Support of R&D.....	67,778,096	68,295,000	73,710,000
Education and Training.....	3,957,319	4,260,000	4,134,000
Collection of Information.....	215,953	145,000	156,000
TOTAL.....	\$71,951,268	\$72,500,000	\$78,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	0	0	0
Dollars Requested (Total).....	90	90	90
Action Summary			
Number of Awards.....	0	0	0
Dollars Obligated (Total).....	71,951,268	72,500,000	78,000,000
Dollar Distribution by Performer			
Universities.....	0	0	0
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	71,951,268	72,500,000	78,000,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	0	0	0
Amount of Scientist Support.....	0	0	0
Number of Years of Scientist Support.....	0	0	0
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	0	0	0
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	0	0	0
Other Direct Research Costs*	0	0	0
Indirect Costs.....	71,951,268	72,500,000	78,000,000
TOTAL.....	\$71,951,268	\$72,500,000	\$78,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

U. S. Antarctic Program

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	9102,612,951	9106,024,168	9104,090,000
Applied Research.....	227,634	135,000	110,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	102,840,585	106,159,168	104,200,000
(Conduct of R&D Performed by Colleges and Universities.)..	(9,510,780)	(9,806,000)	(10,227,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	8,000,000	9,000,000	12,800,000
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	8,000,000	9,000,000	12,800,000
Total, Support of R&D.....	110,840,585	115,159,168	117,000,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	9110,840,585	9115,159,168	9117,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	258	263	270
Dollars Requested (Total).....	9193,100,000	9198,820,000	9162,217,000
Action Summary			
Number of Awards.....	146	151	157
Dollars Obligated (Total).....	110,840,585	115,159,168	117,000,000
Average Award Size.....	759,182	764,632	746,144
Dollar Distribution by Performer			
Universities.....	9,510,780	9,806,000	10,227,000
Industry.....	22,531,340	23,424,000	27,542,000
Federal Agencies.....	77,728,711	80,815,168	79,094,000
Other.....	1,072,534	1,112,000	1,137,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	173	180	188
Amount of Scientist Support.....	1,968,091	2,029,000	2,117,000
Number of Years of Scientist Support.....	40	41	43
Postdoctoral Support			
Number of Postdoctorals Supported.....	20	21	22
Amount Postdoctoral Support.....	291,739	301,000	314,000
Graduate Students			
Number of Graduate Students Supported.....	80	82	86
Amount Graduate Student Support.....	738,050	762,000	795,000
Other Personnel Costs			
Amount of Support.....	28,205,118	29,312,000	29,754,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	8,000,000	9,000,000	12,800,000
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	13,892,073	14,441,000	14,647,000
Other Direct Research Costs*	94,969,016	96,454,168	93,588,000
Indirect Costs.....	2,775,499	2,860,000	2,985,000
TOTAL.....	9110,840,585	9115,159,168	9117,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

U.S. Antarctic Research Program

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$11,047,885	\$11,390,000	\$11,890,000
Applied Research.....	107,634	110,000	110,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	11,155,519	11,500,000	12,000,000
(Conduct of R&D Performed by Colleges and Universities)...	(9,360,780)	(9,650,000)	(10,069,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	11,155,519	11,500,000	12,000,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$11,155,519	\$11,500,000	\$12,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	247	252	258
Dollars Requested (Total).....	942,600,300	943,919,500	945,625,000
Action Summary			
Number of Awards.....	135	139	145
Dollars Obligated (Total).....	11,155,519	11,500,000	12,000,000
Average Award Size.....	\$2,633	\$2,633	\$2,633
Average Award Duration (Years).....	1.3	1.0	1.3
Dollar Distribution by Performer			
Universities.....	9,360,780	9,650,000	10,069,000
Industry.....	394,739	407,000	425,000
Federal Agencies.....	1,100,000	1,134,000	1,163,000
Other.....	300,000	309,000	323,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	175	180	188
Amount of Scientist Support.....	1,968,091	2,029,000	2,117,000
Number of Years of Scientist Support.....	40	41	43
Postdoctoral Support			
Number of Postdoctorals Supported.....	20	21	22
Amount Postdoctoral Support.....	291,739	301,000	314,000
Graduate Students			
Number of Graduate Students Supported.....	80	82	86
Amount Graduate Student Support.....	738,850	762,000	795,000
Other Personnel Costs			
Amount of Support.....	2,000,118	2,062,300	2,152,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	640,750	661,000	689,000
Other Direct Research Costs*.....	2,740,273	2,825,000	2,948,000
Indirect Costs.....	2,775,698	2,860,000	2,985,000
TOTAL.....	\$11,155,519	\$11,500,000	\$12,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Operations Support ProgramResearch and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$91,565,066	\$94,634,168	\$92,200,000
Applied Research.....	120,000	25,000	0
Development.....	0	0	0
Subtotal, Conduct of R&D.....	91,685,066	94,659,168	92,200,000
(Conduct of R&D Performed by Colleges and Universities.)..	(150,000)	(156,000)	(158,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	8,000,000	9,000,000	12,800,000
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	8,000,000	9,000,000	12,800,000
Total, Support of R&D.....	99,685,066	103,659,168	105,000,000
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$99,685,066	\$103,659,168	\$105,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	11	11	12
Dollars Requested (Total).....	\$110,500,000	\$114,905,000	\$116,392,000
Action Summary			
Number of Awards.....	11	11	12
Dollars Obligated (Total).....	99,685,066	103,659,168	105,000,000
Average Award Size.....	9,062,279	9,062,279	9,262,279
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	150,000	156,000	158,000
Industry.....	22,136,801	23,019,000	27,117,000
Federal Agencies.....	76,625,711	79,681,168	76,911,000
Other.....	772,554	803,000	814,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	0	0	0
Amount of Scientist Support.....	0	0	0
Number of Years of Scientist Support.....	0	0	0
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	26,205,000	27,250,000	27,602,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	8,000,000	9,000,000	12,800,000
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	13,251,323	13,780,000	13,958,000
Other Direct Research Costs*	52,228,743	53,629,168	50,640,000
Indirect Costs.....	0	0	0
TOTAL.....	\$99,685,066	\$103,659,168	\$105,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

U.S. Antarctic Program - Additional Detail on Use of Funds

OPERATIONS SUPPORT

(Dollars in Millions)

	Estimate FY 1985	Current Plan FY 1986	Estimate FY 1987
Naval Support Force.....	\$61.34	\$62.80	\$70.90
Contract Support.....	21.82	23.50	29.32
U.S. Coast Guard Icebreaker.....	15.00	15.20	2.80
Research Ship Charter (UNOLS).....	0.30	2.80	0.30
Other Costs.....	2.53	1.36	1.80
TOTAL.....	\$99.69	\$103.66	\$105.00

* After budget base transfers for fixed costs, only incremental costs are funded by NSF.

COST BREAKOUT: NAVAL RESEARCH COSTS

(Dollars in Millions)

	Estimate FY 1985	Current Plan FY 1986	Estimate FY 1987
Military Personnel.....	\$25.88	\$26.70	\$27.70
Aircraft Operations.....	13.04	14.50	14.80
Intercontinental Airlift.....	3.50	3.80	4.00
Intercontinental Sealift.....	2.83	3.00	3.10
Ground Fuel and Power.....	2.53	3.40	3.60
Other Costs.....	13.26	11.40	17.60*
TOTAL.....	\$62.04	\$62.80	\$70.80

* Includes \$5,000,000 for aircraft upgrade.

Science and Engineering Education

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$454,508	\$500,000	\$500,000
Applied Research.....	2,596,463	3,124,000	3,124,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	3,050,971	3,624,000	3,624,000
(Conduct of R&D Performed by Colleges and Universities.)..	(1,651,457)	(1,914,000)	(1,914,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	3,050,971	3,624,000	3,624,000
Education and Training.....	78,944,582	83,344,325	85,300,000
Collection of Information.....	60,266	76,000	76,000
TOTAL.....	\$81,955,819	\$87,044,325	\$89,000,000

Quantitative Data Tables

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	7,889	8,667	9,167
Dollars Requested (Total).....	\$733,245,646	\$807,589,800	\$825,569,800
Action Summary			
Number of Awards.....	747	803	896
Dollars Obligated (Total).....	\$1,955,819	\$7,044,325	\$9,000,000
Average Award Size.....	109,713	108,439	99,313
Dollar Distribution by Performer			
Universities.....	\$4,144,870	\$7,558,325	\$9,414,000
Industry.....	\$19,358	\$61,000	\$61,000
Federal Agencies.....	\$49,257	\$16,000	\$16,000
Other.....	\$16,722,334	\$8,309,000	\$8,409,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	637	696	696
Amount of Scientist Support.....	\$3,701,385	\$4,931,000	\$4,931,000
Number of Years of Scientist Support.....	283	317	317
Postdoctoral Support			
Number of Postdoctorals Supported.....	23	25	25
Amount Postdoctoral Support.....	\$726,762	\$798,000	\$798,000
Graduate Students			
Number of Graduate Students Supported.....	1,796	1,807	1,787
Amount Graduate Student Support.....	\$27,608,072	\$27,550,325	\$27,305,000
Other Personnel Costs			
Amount of Support.....	\$9,294,644	\$10,025,000	\$10,025,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	\$6,172,415	\$6,773,000	\$6,773,000
Other Direct Research Costs*	\$15,263,542	\$16,933,800	\$17,116,000
Indirect Costs.....	\$9,188,999	\$10,033,200	\$10,052,000
TOTAL.....	\$81,955,819	\$87,044,325	\$89,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Research Career Development

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$0	\$0	\$0
Applied Research.....	0	0	0
Development.....	0	0	0
Subtotal, Conduct of R&D.....	0	0	0
(Conduct of R&D Performed by Colleges and Universities.)..	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	0	0	0
Education and Training.....	27,297,922	27,344,325	27,300,000
Collection of Information.....	0	0	0
TOTAL.....	\$27,297,922	\$27,344,325	\$27,300,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	5,004	6,000	6,000
Dollars Requested (Total).....	\$86,806,990	\$104,065,800	\$104,065,800
Action Summary			
Number of Awards.....	142	142	142
Dollars Obligated (Total).....	27,297,922	27,344,325	27,300,000
Average Award Size.....	192,239	192,239	192,239
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	25,195,358	25,673,325	25,329,000
Industry.....	200,000	200,000	200,000
Federal Agencies.....	0	0	0
Other.....	1,102,564	1,471,000	1,571,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	0	0	0
Amount of Scientist Support.....	0	0	0
Number of Years of Scientist Support.....	0	0	0
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	1,560	1,550	1,530
Amount Graduate Student Support.....	25,966,408	25,740,325	25,503,000
Other Personnel Costs			
Amount of Support.....	0	0	0
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	0	0	0
Other Direct Research Costs*	998,599	1,229,800	1,412,000
Indirect Costs.....	332,915	366,200	385,000
TOTAL.....	\$27,297,922	\$27,344,325	\$27,300,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Materials Development and Research and Informal Science Education

Research and Development Special Analysis

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$454,508	\$500,000	\$500,000
Applied Research.....	909,016	1,000,000	1,000,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	1,363,524	1,500,000	1,500,000
(Conduct of R&D Performed by Colleges and Universities)...	(1,037,000)	(1,141,000)	(1,141,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	1,363,524	1,500,000	1,500,000
Education and Training.....	21,361,894	23,500,000	23,500,000
Collection of Information.....	0	0	0
TOTAL.....	\$22,725,418	\$25,000,000	\$25,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	522	574	574
Dollars Requested (Total).....	\$271,281,933	\$298,434,000	\$298,434,000
Action Summary			
Number of Awards.....	98	108	108
Dollars Obligated (Total).....	22,725,418	25,000,000	25,000,000
Average Award Size.....	231,892	231,892	231,892
Average Award Duration (Years).....	2.0	2.0	2.0
Dollar Distribution by Performer			
Universities.....	18,434,199	20,279,000	20,279,000
Industry.....	419,358	461,000	461,000
Federal Agencies.....	469,257	516,000	516,000
Other.....	3,402,604	3,744,000	3,744,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	280	308	308
Amount of Scientist Support.....	6,590,369	7,250,000	7,250,000
Number of Years of Scientist Support.....	90	99	99
Postdoctoral Support			
Number of Postdoctorals Supported.....	8	9	9
Amount Postdoctoral Support.....	681,762	750,000	750,000
Graduate Students			
Number of Graduate Students Supported.....	128	142	142
Amount Graduate Student Support.....	1,363,525	1,500,000	1,500,000
Other Personnel Costs			
Amount of Support.....	1,136,270	1,250,000	1,250,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	454,508	500,000	500,000
Other Direct Research Costs*	4,590,369	7,250,000	7,250,000
Indirect Costs.....	5,908,615	6,500,000	6,500,000
TOTAL.....	\$22,725,418	\$25,000,000	\$25,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Teacher Preparation and Enhancement**Research and Development Special Analysis**

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research	50	50	50
Basic Research.....	0	0	0
Applied Research.....	0	0	0
Development.....	0	0	0
Subtotal, Conduct of R&D.....	0	0	0
(Conduct of R&D Performed by Colleges and Universities.)..	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D.....	0	0	0
Education and Training.....	25,188,387	27,000,000	27,000,000
Collection of Information.....	0	0	0
TOTAL.....	\$25,188,387	\$27,000,000	\$27,000,000

Quantitative Data Table

	Actual FY 1985	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	991	1,062	1,062
Dollars Requested (Total).....	\$329,654,742	\$353,364,000	\$353,364,000
Action Summary			
Number of Awards.....	260	279	279
Dollars Obligated (Total).....	25,188,387	27,000,000	27,000,000
Average Award Size.....	96,878	96,878	96,878
Average Award Duration (Years).....	2.0	2.0	2.0
Dollar Distribution by Performer			
Universities.....	14,304,477	15,333,000	15,333,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	10,883,910	11,667,000	11,667,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	330	354	354
Amount of Scientist Support.....	6,800,000	7,289,000	7,289,000
Number of Years of Scientist Support.....	135	145	145
Postdoctoral Support			
Number of Postdoctorals Supported.....	15	16	16
Amount Postdoctoral Support.....	45,000	48,000	48,000
Graduate Students			
Number of Graduate Students Supported.....	105	113	113
Amount Graduate Student Support.....	260,000	279,000	279,000
Other Personnel Costs			
Amount of Support.....	7,998,000	8,573,000	8,573,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	721,528	773,000	773,000
Other Direct Research Costs*	6,454,000	6,918,000	6,918,000
Indirect Costs.....	2,909,859	3,120,000	3,120,000
TOTAL.....	\$25,188,387	\$27,000,000	\$27,000,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Studies and Program Assessment

Research and Development Special Analysis

	Actual FY 1965	Estimate FY 1966	Estimate FY 1967
Support of R&D			
Conduct of Research			
Basic Research.....	\$0	\$0	\$0
Applied Research.....	1,687,447	2,124,000	2,124,000
Development.....	0	0	0
Subtotal, Conduct of R&D.....	1,687,447	2,124,000	2,124,000
(Conduct of R&D Performed by Colleges and Universities.)..	(614,457)	(773,000)	(773,000)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	1,687,447	2,124,000	2,124,000
Education and Training.....	0	0	0
Collection of Information.....	60,266	76,000	76,000
TOTAL.....	\$1,747,713	\$2,200,000	\$2,200,000

Quantitative Data Tables

	Actual FY 1965	Estimate FY 1966	Estimate FY 1967
Proposal Summary			
Number of Proposals Received.....	24	30	30
Dollars Requested (Total).....	\$7,726,253	\$9,726,000	\$9,726,000
Action Summary			
Number of Awards.....	13	16	16
Dollars Obligated (Total).....	1,747,713	2,200,000	2,200,000
Average Award Size.....	134,439	137,500	137,500
Average Award Duration (Years).....	1.0	1.0	1.0
Dollar Distribution by Performer			
Universities.....	614,457	773,000	773,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	1,133,256	1,427,000	1,427,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	27	34	34
Amount of Scientist Support.....	311,016	392,000	392,000
Number of Years of Scientist Support.....	56	73	73
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	2	3	3
Amount Graduate Student Support.....	18,139	23,000	23,000
Other Personnel Costs			
Amount of Support.....	160,374	202,000	202,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	0	0	0
Other Direct Research Costs*	1,320,574	1,536,000	1,536,000
Indirect Costs.....	37,610	47,000	47,000
TOTAL.....	\$1,747,713	\$2,200,000	\$2,200,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

College Science Instrumentation**Research and Development Special Analysis**

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	90	90	90
Applied Research.....	0	0	0
Development.....	0	0	0
Subtotal, Conduct of R&D.....	0	0	0
(Conduct of R&D Performed by Colleges and Universities.)...	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Subtotal, R&D Facilities & Major Equipment.....	0	0	0
Total, Support of R&D.....	0	0	0
Education and Training.....	4,996,379	5,500,000	7,300,000
Collection of Information.....	0	0	0
TOTAL.....	\$4,996,379	\$5,500,000	\$7,300,000

Quantitative Data Table

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	1,348	1,000	1,300
Dollars Requested (Total).....	\$37,775,729	\$42,000,000	\$40,000,000
Action Summary			
Number of Awards.....	234	258	351
Dollars Obligated (Total).....	4,996,379	5,500,000	7,500,000
Average Award Size.....	21,352	21,352	21,352
Average Award Duration (Years).....	2.0	2.0	2.0
Dollar Distribution by Performer			
Universities.....	4,996,379	5,500,000	7,300,000
Industry.....	0	0	0
Federal Agencies.....	0	0	0
Other.....	0	0	0
Personnel			
Senior Scientists			
Number of Scientists Supported.....	0	0	0
Amount of Scientist Support.....	0	0	0
Number of Years of Scientist Support.....	0	0	0
Postdoctoral Support			
Number of Postdoctorals Supported.....	0	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	0	0	0
Amount Graduate Student Support.....	0	0	0
Other Personnel Costs			
Amount of Support.....	0	0	0
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	0	0	0
Other Equipment and Instrumentation.....	4,996,379	5,500,000	7,300,000
Other Direct Research Costs*	0	0	0
Indirect Costs.....	0	0	0
TOTAL.....	\$4,996,379	\$5,500,000	\$7,300,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

Special Foreign CurrencyResearch and Development Special Analysis

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Support of R&D			
Conduct of Research			
Basic Research.....	\$1,899,730	\$474,962	\$473,000
Applied Research.....	829,894	290,137	202,300
Development.....	0	0	0
Subtotal, Conduct of R&D.....	2,729,624	967,099	675,300
(Conduct of R&D Performed by Colleges and Universities)...	(1,709,710)	(600,576)	(420,300)
R&D Facilities			
Land, Building and Fixed Equipment.....	0	0	0
Major Equipment.....	99,881	35,328	25,000
Subtotal, R&D Facilities & Major Equipment	99,881	35,328	25,000
Total, Support of R&D.....	2,829,505	1,002,417	700,300
Education and Training.....	0	0	0
Collection of Information.....	0	0	0
TOTAL.....	\$2,829,505	\$1,002,417	\$700,000

Quantitative Data Table

	Actual FY 1983	Estimate FY 1986	Estimate FY 1987
Proposal Summary			
Number of Proposals Received.....	158	56	39
Dollars Requested (Total).....	\$6,400,000	\$2,260,000	\$1,600,300
Award Summary			
Number of Awards.....	165	48	34
Dollars Obligated (Total).....	2,829,505	1,002,417	700,000
Average Award Size.....	17,148	20,864	20,864
Average Award Duration (Years).....	1.2	1.2	1.2
Dollar Distribution by Performer			
Universities.....	1,709,701	600,576	420,000
Industry.....	0	0	0
Federal Agencies.....	399,922	141,312	100,000
Other.....	719,882	260,529	180,000
Personnel			
Senior Scientists			
Number of Scientists Supported.....	136	48	34
Amount of Scientist Support.....	2,019,700	717,159	500,000
Number of Years of Scientist Support.....	39	14	10
Postdoctoral Support			
Number of Postdoctorals Supported.....	1	0	0
Amount Postdoctoral Support.....	0	0	0
Graduate Students			
Number of Graduate Students Supported.....	29	10	7
Amount Graduate Student Support.....	99,882	35,328	25,000
Other Personnel Costs			
Amount of Support.....	200,046	70,656	50,000
R&D Facilities, Equipment and Instrumentation			
Land, Buildings and Fixed Equipment.....	0	0	0
Major Equipment.....	99,881	35,328	25,000
Other Equipment and Instrumentation.....	0	0	0
Other Direct Research Costs*	409,996	143,946	100,000
Indirect Costs.....	0	0	0
TOTAL.....	\$2,829,505	\$1,002,417	\$700,000

*Includes: Supplies, Publications, Consultants, Computer Services, Subcontracts, Travel.

National Science Foundation

WASHINGTON, D. C. 20550

APPENDIX A

**Justification of Estimates
of Appropriations**

Fiscal Year 1985



**TO
THE CONGRESS**

INTRODUCTION

This report is produced annually to accompany the annual budget submission to the Congress and is reconciled with the official accounting records of the Foundation. The report reflects the number and dollar value of NSF program grants and contracts made in Fiscal Year 1985.

The report is divided into four principal sections: (1) NSF Salaries and Expenses, Research and Related Activities Appropriations; (2) U.S. Antarctic Activities; (3) Science and Engineering Education Activities and Fellowship Awards; and (4) NSF Special Foreign Currency. Four subsections are provided which show awards by: State, Federal Government, U.S. Possessions, and Foreign Countries. The detail in these sections and subsections is sequenced alphabetically by grantee or contractor. A summary report also precedes each of the four sections.

The total number of awards and the total dollar amounts for each grantee or contractor are displayed, followed by a breakdown of these totals by NSF program activity. Fellowships data reflect the total number of fellows supported at each institution under this program. Award amounts with asterisks (*) indicate split funding between one or more activities with the award counted against the primary funding activity.

Awards are grouped by program activities as they existed in FY 1985 and will not necessarily agree with other parts of the budget due to reorganizations.

FISCAL YEAR 1985

PROGRAM GRANTS AND CONTRACTS AWARDED

FROM

**NSF SALARIES AND EXPENSES APPROPRIATION
RESEARCH AND RELATED ACTIVITIES APPROPRIATION**

SUMMARY Amount in Thousands of Dollars	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Astronomical, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Scientific Completing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Alabama	45	2,729	12	664	12	793	13	1,085	7	265	1	115		
Alaska	46	6,422	2	152	2	210	9	582	13	5,567	4	3		
Arizona	222	38,538	55	5,598	62	2,622	56	3,021	56	2,125	11	764	4	70
Arkansas	24	1,311	8	360	2	107	7	455	2	276	2	89		
California	2,228	184,915	557	57,667	312	26,928	639	44,035	435	50,951	86	5,120	9	6,511
Colorado	284	76,452	76	7,188	44	3,274	65	5,478	80	50,897	9	825	6	3,658
Connecticut	211	16,835	71	5,315	25	1,712	87	5,364	22	1,876	6	56		
Delaware	47	6,992	17	785	14	1,074	10	734	16	1,560	5	107		
District of Columbia	219	42,860	27	2,225	34	1,880	66	4,429	20	21,944	42	6,368		8
Florida	267	28,114	53	6,527	36	2,164	82	6,752	83	8,207	13	460	4	1
Georgia	185	12,512	49	2,772	27	2,094	79	5,821	27	1,394	7	623		
Hawaii	100	7,271	11	660	4	452	20	1,420	44	4,367	13	370		
Idaho	9	583	5	105	2	156	3	46			1	75		
Illinois	120	68,683	271	33,597	119	8,365	214	13,345	78	6,542	13	815	5	5,816
Indiana	318	35,470	137	19,117	62	5,626	84	5,011	17	1,861	15	792	1	1,991
Iowa	116	6,346	31	1,086	25	1,264	44	2,406	13	723	3	68		
Kansas	60	2,920	19	1,157	15	750	27	1,037	4	211	3	58	4	3
Kentucky	55	2,961	22	1,020	6	514	16	1,063	2	121	6	198	4	2
Louisiana	73	3,599	28	1,374	5	225	27	1,588	10	699	3	185	4	6
Maine	50	3,443	5	404	7	432	16	1,084	19	1,489	3	232		
Maryland	110	26,317	98	6,513	46	4,557	93	5,759	56	5,601	16	2,181	4	54
Massachusetts	1,050	110,417	280	36,364	137	13,934	316	29,215	272	36,121	56	5,285	6	56
Michigan	489	36,435	162	15,086	72	4,926	123	9,907	49	3,883	22	1,419	1	52
Minnesota	203	16,377	74	5,057	41	2,679	58	3,719	20	1,373	8	612	4	3,275
Mississippi	21	1,411	5	394	5	171	7	452	1	24	3	361	4	7

Page 1

SUMMARY (Amount in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Earth and Ocean Sciences		Scientific Interdisciplinary and International Affairs		Advanced Scientific Research and Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Missouri	165	9,228	10	1,465	30	2,050	61	3,566	22	1,276	12	489		
Montana	29	1,093	6	786	5	226	12	471	2	267	3	21		
Nebraska	50	4,684	10	1,566	3	126	10	991	6	1,210	5	166		
Nevada	20	1,616	3	192	6	616	6	167	7	721	2	78		
New Hampshire	50	3,181	13	681	7	372	16	981	16	1,050	6	766		
New Jersey	107	56,078	116	13,672	69	3,169	16	6,271	50	2,126	15	1,577	1	9,612
New Mexico	60	6,029	16	609	6	311	27	1,086	29	947	1	277		
New York	162	146,666	403	47,219	215	20,622	410	26,236	114	20,911	57	2,679	1	5,315
North Carolina	286	21,537	77	5,786	37	2,069	113	7,216	61	6,286	18	1,676	6	77
North Dakota	10	492	2	92	1	59	4	175	2	91	1	75		
Ohio	293	19,596	136	10,781	36	2,500	95	6,226	22	2,033	12	516	2	65
Oklahoma	81	6,217	25	1,679	8	326	30	1,356	13	766	5	606	6	2
Oregon	713	16,681	46	3,636	16	1,172	31	6,561	14	7,117	9	394	1	1
Pennsylvania	658	51,948	276	26,698	151	10,024	182	11,160	58	6,343	29	1,703	7	266
Rhode Island	184	16,893	50	5,699	27	1,637	27	1,566	66	7,635	5	87	6	69
South Carolina	83	7,248	24	1,630	10	1,169	26	2,166	9	2,116	6	70		
South Dakota	15	812	1	28	2	127	2	60	8	553	2	63		
Tennessee	91	7,657	20	2,732	6	422	47	3,539	5	272	4	603		
Texas	525	36,966	172	12,263	91	6,237	162	8,072	96	7,756	26	1,760	6	58
Utah	137	11,091	65	5,642	15	1,261	22	2,635	22	1,211	3	641		
Vermont	17	916	5	169	2	89	7	266	1	30	2	132		
Virginia	223	16,876	63	3,716	42	3,655	19	6,469	13	667	23	1,908	1	2,618
Washington	166	29,483	76	6,575	45	2,728	116	7,988	180	11,616	11	721	1	63
West Virginia	9	27,992	2	129	3	168	2	167	2	26,450			6	6
Wisconsin	270	22,487	103	10,358	37	2,508	188	5,553	22	1,983	7	925	1	68

PAGE: 2

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Sciences and Social Sciences		Astronomical Sciences and Ocean Sciences		Scientific Technological and International Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
California														
Addiction Research Fdn	1	54					1	54						
Adelant Technology	0	39									0	39		
Adv Res & Applicat'n Corp	0	154									0	154		
Aerospace Corporation	3	292								3	292			
Aphubian Associates	2	292			2	292								
Aquarium Institute	2	310					2	310						
Asur Soc of Zoologists	4	23					4	23						
American Inst Fur Res-Cal	1	19					1	19						
Asac Engineers Inc	1	77			1	77								
Amur Electronic Design	0	48									0	48		
Applied Decision Analysis	2	382									2	382		
Applied Superconduct Inc	0	161									0	161		
Applied Technology Council	3	258			3	258								
Aquatic Systems Inc	0	137									0	137		
Beckman Res Inst City Hope	3	156					3	156						
Building Systems Dev Inc	1	79			1	79								
Cal Acad of Sciences	3	996					3	996						
Cal St Cal at Bakersfield	1	109					1	79						
Cal St U Dominguez Hills	2	310												
Cal St Univ Fullerton	7	306					1	125		3	135	1	26	
Cal St Univ Hayward	2	95								1	39			
Cal St Univ Long Beach	7	568			2	278						1	15	10
Cal St Univ Los Angeles	4	473					2	115				1	297	
Cal St Univ Northridge	3	101										1	0	

PAGE: 3

PAGE: 3

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Sciences and Social Sciences		Astronomy, Earth, and Ocean Sciences		Space, Technological, and Engineering Affairs	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
California												
Cal St-Los Angeles Fdn	2	127	2	127								
Cal State Univ Chico	1	28					1	28				
Cal State Univ Sacramento	1	25									1	25
Calif St W San Lo Obispo	2	90										
California Inst of Tech	159	21,530	60	7,623	31	2,699	10	1,053	2	90	5	162
California Publ Wlth Fdn	2	119			1	59	1	60				
City of Hope Natl Med Ctr	1	106					1	106				
Claremont Mc Kenna Col	1	100					1	100				
Cognos Associates	1	100									1	100
Computech	2	92			2	92						
Ctr Adv Study Behav Sci	1	600					1	600				
Curtis Mado Engineering		39										39
Cyclotronics Inc		152										152
Earthquake Eng Res Inst	1	120			1	120						
Eeg Systems Laboratory	1	87			1	87						
EnergEConmatl Ruch Corp		99										99
FIMEC Inc	1	110			1	110						
Failure Analysis Assoc		39										39
Fermentec Corporation		39										39
Frederic Berk Fdn Inc	4	120	2	57		25	2	24		21		
GA Technologies Inc	4	5,716										
H J Degenhele Assoc Engr	1	42			1	42						
Harvey Mudd Col	6	227	6	227								
Hughes Aircraft Co-Mr Lab	1	219			1	219						
												5,716

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Agricultural, and Social Sciences		Astronomical, Atmospheric, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
California														
Humboldt State University	6	194					2	106	2	55	2	32		
Inst For Policy/Mgmt Res	1	19									1	19		
Inst of Human Origins	2	158					1	110	1	48				
Integrated System Inc-Cal	•	165									•	145		
Jet Propulsion Laboratory	2	56	2	56										
Karietta & Associates	2	75			2	75								
La Jolla Cancer Res Fdn	2	165					2	165						
La Jolla Institute	1	33							1	33				
Lawrence Berkeley Lab	6	128	1	50					2	27	3	42		
Lawrence Livermore Lab	1	5	1	5										
Lotheard M&S-Palo Alto	9	268							5	348				
Loma Linda Univ-Sch Med	1	241					1	241						
Math Sci Res Inst	3	2,248	2	2,193			1	46						
Medical Biology Institute	1	95					1	95						
Medical Research Inst	1	51					1	51						
Millie College	1	37	1	37										
Naval Postgraduate School	5	383	1	5					3	365	1	13		
Occidental Coll	1	34					1	34						
Ocean Genetics Inc	•	198									•	198		
Optivision Inc	•	100									•	100		
PSA Rancho Los Amigos Hsp	1	96			1	96								
Perceptronics Inc	3	253					2	208						
Point Loma College	1	47	1	47							1	44		
Polar Research Lab Inc	1	39							1	39				

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Agriculture, Atmospheric, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Research and Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
California														
Pasadena Cal	4	172	2	61			2	111						
Rancho Santa Ana Bot Gdn	3	338					3	330						
Rand Corporation	8	817					7	675			1	141		
Relational Technology Inc	•	120									•	120		
Rockwell International	2	222	2	161	•	61								
SRI International	21	3,239	10	968	5	429	1	171	6	1,649			1	27
San Diego Soc Nat History	1	37					1	37						
San Diego State Univ	20	1,242	6	102	2	177	7	416	7	467				
San Francisco State Univ	2	101					2	101						
San Jose State University	16	1,099	3	30	•	9	3	186	10	1,056				
Science Appl Intl Corp	2	244							1	45	1	199		
Scientific Service Inc	1	99			1	99								
Scripps Clinic & Res Fdn	3	350					4	346	1	107	1	4		
SeaSpace	1	107												
Soc Vertebrate Paleontology	1	8												
Southeast Museum	1	40												
Stanford Univ	227	23,027	80	13,897	40	3,875	61	4,315	25	2,442	9	255	•	91
Stanford Univ-Hamline Sta	2	188					1	185	1	83				
Stanford Univ-Sch of Med	5	415					5	415						
Stratemon Inc	•	36									•	36		
Y&W Inc-Redondo Beach	1	190							1	190				
Tech Develop of Calif Inc	•	40									•	40		
Tera Advanced Servs Corp	1	30							1	30				
The Earth Tech Corp.	1	129			1	129								

PAGE: 6

PAGE: 6

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Sciences and Social Sciences		Agriculture, Earth and Ocean Sciences		Space, Technological and Interdisciplinary Affairs		Advanced Research and Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
California														
The L A City Hall Nat Hist	6	386					5	344	1	41				
The Salk Institute	5	412			5	59	5	352						
U of Cal LA-Sch of Med	4	261					4	261						
U of Cal SC-Lick Observ	11	452							11	848				4
U of Cal SD-Revelle Cal	2	84			1	58	1	26						
U of Cal SD-Sch of Med	1	71					1	71						
U of Cal SD-Serlape Inst	124	18,038	1	47	1	4	6	674	15	17,490	1	12		
U of Cal SF-Sch of Med	4	191					4	192						
U of Cal San Diego	138	18,577	49	3,649	16	1,432	52	3,378	18	2,885	5	128		
U of Cal San Francisco	29	2,281	1	52			24	2,821			4	287		
U of Cal Santa Barbara	91	9,984	34	4,602	18	1,950	24	1,342	19	2,028	3	48	1	25
U of Cal Santa Cruz	45	3,363	9	768			18	1,268	17	1,128	1	61		
U of Cal-Irvine	75	5,759	38	2,675	4	303	35	2,393	5	378	1	18		
U of Cal-LA-Agr Exp Sta	1	3					1	3						
U of Southern Cal-Sch Med	3	281					3	281						
Univ of Cal Los Angeles	223	17,375	69	7,619	28	1,145	83	7,413	42	3,357	8	153	1	130
Univ of Cal Riverside	48	3,153	18	473	1	147	23	1,835	4	446	2	50		
Univ of Cal-Berkeley	348	25,354	185	7,830	86	7,266	181	6,371	37	3,426	11	386		74
Univ of California-Davis	189	7,298	19	1,717	13	884	59	3,614	11	977	7	185		
Univ of Southern Cal	121	8,634	36	2,385	38	2,631	15	748	24	2,418	8	459		
Univ of the Pacific	1	68					1	68						
University of Santa Clara	3	166	2	59	1	76								
Varian Associates	1	93			1	93								
Vector Productions	1	410											1	47

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Biomedical Sciences		Astronomical and Atmospheric Sciences and Oceanography		Scientific Periodicals and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
California														
Vap Associates Inc	1	68			1	60								
Vuebelles Corporation	*	40									*	40		
Weidinger Associates	1	88			1	88								
Weidinger Assoc-Memlo Pk	1	36			1	36								
Zeecon Corporation	3	184					3	184						
TRAVEL & INDIVIDUAL AWARDS	29	981	11	385	2	3	10	537	*	18	2	45		
STATE TOTAL:	180	915	57	667	24	926	46	835	50	451	86	5120	64	511
	2,828		557		382		639		435				9	
Colorado														
ABEX Incorporated	*	40									*	40		
AIMS/Aspen Inst M S-Cole	1	8					1	8						
Aspen Center For Physics	2	159	2	159										
Atkinson-Moland&Assoc Inc	4	216			4	216								
Colorado College	2	215					1	67	1	122	*	26	1	34
Colorado School of Mines	9	454	4	193	3	183			1	43			2	3,022
Colorado State University	77	9,978	25	1,928	13	840	16	2,272	18	1,771	3	134		
DFM Engineering Inc	*	34									*	34		
F. Roosevelt Ins Cancer Res	1	75					1	75						
Fort Lewis College	*	11	*	11										
Hyperline Inc	*	36									*	36		
Met Ctr For Aspen Res	17	65,728	1	228							*	201	3	504
Met Jewish Hosp & Res Ctr	2	130					2	130						

PAGE: 8

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Botanical and Social Sciences		Astronomical, Atmospheric, Earth, and Ocean Sciences		Scientific, Technological and Instructional Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Colorado														
Omni Corporation	0	27									0	27		
Regis College	1	4					1	4						
Research Inst of Colorado	1	0	1	0										
Rocky Mt Software Engr	1	9	1	9										
Rocky Mtn Biol Lab	2	115					2	115						
Stevens Research Inc	0	39									0	39		
Stevens - LI & Assoc Inc	0	153									0	153		
Solar Energy Research Inc	1	22			1	22								
Sunburst Recovery Inc	0	39									0	39		
U Colo at Colo Springs	1	185			1	185					0	39		
Univ Colorado at Boulder	137	11,529	39	4,415	25	1,015	38	2,055	38	2,426	5	00	0	75
Univ of Colo Hlth Sci Ctr	6	495					6	495					0	20
Univ of Colo at Denver	1	48	1	20										
Univ of Southern Colorado	1	35					1	35						
University of Denver	16	1,000	3	170			3	150	9	749	1	10		
TRAVEL & INDIVIDUAL AWARDS	5	117	1	43	1		1	52						
STATE TOTAL:	70,452		78	1,180	3,204		5,470		58,097		9	825	3,658	
	206				40		65		80			6		
Connecticut														
A J Devaney Associates	0	34									0	34		
Advanced Fuel Research	0	142									0	142		
Fairfield Univ	1	22	1	22										

PAGE: 9

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Atmospheric Earth and Ocean Sciences		Scientific Technological and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Connecticut														
John B. Pierce Fdn of Conn	1	120					1	120						
Marine Surveys Inc	0	39									0	39		
Sigma XI Sc Res Soc W Aer	1	103									1	103		
Trinity College	2	129			1	60			1	69				
U of Conn-Marine Sci Inst	1	67							1	67				
University of Bridgeport	1	79					1	79						
University of Connecticut	30	2,462	9	813	6	483	19	1,165						
Wesleyan Univ	10	897	9	361			5	383	3	170	1	5		
Yale Univ Peabody Museum	1	35					1	35						
Yale Univ-Sch of Medicine	7	473					6	447			1	25		
Yale University	140	18,104	49	4,053	18	1,173	53	3,161	17	1,558	3	207		
TRAVEL & INDIVIDUAL AWARDS	4	119	3	65			1	53						
STATE TOTAL:	14,835		5,315		10,717		5,366		1,878		556			
	231		71		25		87		22		6			
Delaware														
Franklin Inst-Maritel Fdn	7	336	2	72					4	243	1	20		
Merckman Manufacturing	0	31									0	31		
Univ Del-Col Marine Stdy	6	491							4	468	2	23		
University of Delaware	53	4,079	15	712	19	1,004	9	681	8	848	2	31		
TRAVEL & INDIVIDUAL AWARDS	1	52					1	52						
STATE TOTAL:	4,982		785		1,684		10	736	1,560		107			
	67		17		19		18		16		5			

PROGRAM GRANTS AND CONTRACTS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS																												
	TOTAL				Mathematical and Physical Sciences				Engineering				Biological Behavioral and Social Sciences				Astronomical Earth and Ocean Sciences				Scientific Technological and International Affairs				Advanced Scientific Computing				
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	
District of Columbia																													
Alliance For Eng'g In H&B	1	5			1	5																							
Amer Assoc For Adv Sci	3	87			1	2			1	14																			
Amer Astronomical Soc	0	3																											
Amer Chemical Soc	3	78	1	39	0	10																							
Amer Sociophysical Union	7	195			1	26																							
Amer Inst of Biol Sci	1	26																											
Amer Political Sci Assoc	1	38																											
Amer Psychological Assoc	1	15																											
Amer Soc For Eng Ed	2	53			1	38																							
Amer Soc for Microbiology	2	22																											
Amer Soc of Mech Eng	1	93																											
Amer Statistical Assoc	4	579	2	35																									
American University	5	486	1	388																									
Assoc of American Univ	1	135																											
Atom Corporation	0	39																											
Brookings Institution	4	585																											
Bureau of Sci Sci Res	1	5																											
Burt Hill Resear Attache	0	39																											
Carnegie Inst of Wash	21	1,652																											
Child Trends Inc	1	98																											
Conf Hd of the Math Sci	1	176	1	176																									
Coun of Grad Schls in US	1	85																											
Creative Presentations	1	24																											
Forefront Inc	1	78																											

PAGE: 11

PAGE: 11

GRANTEES OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Behavioral and Social Sciences		Agriculture, Earth, and Space Sciences		Scientific, Technological, and Engineering Affairs		Arts and Humanities	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
District of Columbia	2	131					2	131						
George Wash Univ-Red Cir	18	1,193	3	161	7	546	3	240	0	20	5	114		
George Washington Univ	2	184					2	184						
Georgetown Univ-Edw Red	13	458	6	332	0	5	6	224			1	296		
Georgetown University	6	564	2	173	1	25	1	58			2	314		
Howard University	1	200							1	200				
Inc Res Inst Technology	1	95									1	95		
Intl City Management Assn	2	114									2	114		
Intl Student Payment Inc	11	25,366							11	25,366				
Joint Ocean Insts Inc	1	60												
League Women Voters U S	1	96									1	60		
Math Assn of America	0	10							0	10				
Modern Talking Pictures	1	158												
Neubauer Associates Inc	21	1,480	3	299	12	882	2	76	4	389	1	158		
Nat Acad Sci-Nat Res Cnl	26	5,510	4	220	2	270	7	873	2	270	11	5,081		
Nat Acad of Sciences	1	17									1	17		
Nat Science Fdnr Assoc	3	423					2	304			1	118		
Resources for Future Inc	1	5							1	5				
Scripta Technica Inc	1	186									1	186		
Small Bus High Tech Inst	1	6					1	6						
See Far Amer Archaeology	1	5					1	5						
See Far Dev Bldg	4	271									4	171		
Syscon Corporation	9	680	3	350	1	49	2	169	3	113				
The Catholic Univ-Amer.	2	160	1	95					1	105				
Univ of DC-Van Ness Camp														4

PAGE: 12

PAGE: 12

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Social Sciences		Atmospheric and Ocean Sciences		Scientific, Technological and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Florida														
U of Fla-Fla St Museum	2	50					2	50						
U of Miami Sch Maritime	63	4,993			1	60	1	64	41	4,037	0	22		
Univ S Fla-Marine Sc Inst	4	310					1	57	3	252				
Univ of Central Florida	4	256	1	69	1	40	2	139						
Univ of Fla-Col of Med	4	207					4	207						
Univ of Miami-Sch of Med	5	402					5	402						
Univ of South Florida	10	647	2	140	1	50	2	80	3	336	2	19		
Univ of West Fla	2	120					2	120						
University of Florida	87	5,376	24	1,661	21	1,313	33	1,802	6	492	5	46		
University of Miami	19	853	6	255	4	169	0	0			1	15		
FRANK G. INDIVIDUAL AWARDS	1	1	1	1	1									
STATE TOTAL:	267	20,114	53	4,327	36	2,164	92	4,752	83	6,287	13	460	1	
Georgia														
Atlanta University	2	427	1	120							1	290		
Augusta College	1	4					1	55			1	4		
Emory Univ-Sch of Med	1	55					1	51						
Emory Univ-Veritas Res Pri	1	51												
Emory University	22	1,332	7	430	1	66	14	826						
Ge Inst Tech Main Campus	54	3,466	10	917	21	1,467	3	227	10	777	2	54		
Ge Tech Research Corp	3	147	2	95	1	31								
Georgia State University	13	641	4	207			7	332	1	56	1	45		
														PAGE: 14

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Atmospheric, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Georgia														
Intl Soc Plant Molec Bio	1	15					1	15						
Ionic Atm. Inc.		139										139		
Kennesaw College		12		12										
Med Cal Ge Res Inst Inc	1	67					1	67						
Morehouse College	1	168					1	168						
Personal Bus Systems Inc		39										39		
Shidoway Inst of Oceanogr	5	261							5	261				
Spelman College	1	59							1	59				
Univ of Ga Marine Inst	1	119					1	119						
Univ of Ga Res Fdn Inc	6	316					5	258						
University of Georgia	68	5,105	15	786	3	587	43	3,653	5	195	2	41		
Valdosta State College	1	19	1	19										
West Georgia College	1	23							1	23				
TRAVEL & INDIVIDUAL AWARDS	2	56			1	1	1	55						
STATE TOTAL:	12	112	2	2,577	2	2,894	5	5,821	1	1,396	3	623		
	185		69		27		78		23					
Hawaii														
Bernice P Bishop Museum	2	65					1	46			1	20		
Multipath Systems Inc		48										48		
Reams Inst.	1	56					1	56						
Research Information Ser	1	64					1	64						
Seaco Inc		105										105		

GRANTEE OR CONTRACTOR		PROGRAM GRANTS AND CONTRACTS														Amount	
		TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Atmospheric Earth and Ocean Sciences		Social, Technological and Interdisciplinary Affairs		Advanced Studies and Computing			
Hawaii		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
U of Hawaii-Col Trop Agr		1	4					1	4								
Univ of Hawaii System Off		1	39					1	39								
Univ of Hawaii-Manoa		92	6,467	11	660	4	432	23	1,211	44	9,367	10	176				
TRAVEL & INDIVIDUAL AWARDS		2	20														
STATE TOTAL:		100	7,271	11	660	4	432	28	1,420	44	9,367	13	370				
Idaho																	
University of Idaho		9	583	5	385	2	156	1	46			1	75				
STATE TOTAL:		9	583	5	385	2	156	1	46			1	75				
Illinois																	
Amer Inst Indian Studies		1	15														
Amer Inst Steel Construct		1	10			1	10										
American Col of Radiology		1	31			1	31										
Argonne National Lab		1	90														
Arms For Symbolic Logic		1	49	6	10			1	39								
Augustana Col		1	25	1	25												
Chicago State University		6	6	6	6												
East Asian His Soc Trust		1	50														
Eastern Illinois Univ		5	205	1	32			3	114	1	50						

PAGE: 16

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Atmospheric and Ocean Sciences		Scientific Technological and International Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Illinois														
Citron Research Inc	0	39									0	39		
Fermi Natl Accelerator Lab	1	18	0	5			1	5						
Field Mus of Natural Hist	10	674					11	643	0	6	3	24		
Ill Research Institute	1	8									1	8		
Jill St Museum	4	72					2	58	2	10				
Illinois Inst of Tech	25	1,076	8	486	12	735	3	194			2	60		
Illinois State Univ	3	175	1	40			2	135						
Loyola Univ of Chicago	4	171			1	55	3	116						
Market Facts Inc	1	53									1	53		
Nat Opinion Research Ctr	6	930					6	930						
Northern Illinois Univ	10	781	6	365			3	135	2	89	3	111		
Northwestern University	133	11,027	61	6,585	24	1,880	34	1,852	7	475	6	152	1	77
Northwestern U-Chgo	1	67					1	67						
Northwestern U-Chgo-Red Sch	2	133					2	133						
Proc/Construction Tech Lab	1	142			1	142								
Sanderson State University	0	3	0	3										
Senoscan Inc	0	38									0	38		
Southern Ill U-Carbondale	7	528	1	35	1	30	5	444						
Southern Ill U-Edwardsville	1	60			1	60								
U of Ill at Sci/Chl Red Sch	1	5					1	5						
Univ of Ill Red Ctr Chgo	1	19	1	19										
Univ of Ill at Chicago	39	1,751	21	774	5	253	8	549	2	132	3	40		
Univ of Illinois-Chgo Ctr	17	1,402	8	480	2	230	7	483						
Univ of Illinois-Urbana	287	33,766	96	14,853	66	4,532	77	4,783	41	3,219	3	11	4	5,645

page: 17

Page: 17

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Atmospheric, Earth, and Ocean Sciences		Space, Technological, and Interdisciplinary Affairs	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Illinois												
University of Chicago	137	15,350	66	9,544	1	313	45	2,195	25	2,545	6	141
Wm Janney Kistner-Massee	1	77			1	77						
TRAVEL & INDIVIDUAL AWARDS	7	201	2	126	2	2					3	73
STATE TOTAL:	68	483	33	997	8	365	13	545	6	542	8	118
	728		271		119		216		78		33	5
Indiana												
Batt St Univ	2	86	1	51			1	55				
Ind U-Pur U-Indiana S Med	2	95					2	95				
Ind U-Purdue U Indiana	6	193	3	54			2	98	1	41		
Indiana U Central Sys Off	1	99					1	99				
Indiana Univ-Bloomington	87	13,634	42	11,368			32	1,824	5	283	7	129
Purdue University	175	15,950	69	9,311	48	6,945	39	2,912	10	684	7	143
St Mary's College	2	44					2	44			1	19
U of Notre Dame	37	3,090	19	2,162	13	670	6	230				
Wabash College	1	31							1	31		
TRAVEL & INDIVIDUAL AWARDS	5	244	3	189	1	1	1	52				
STATE TOTAL:	33	470	19	1,117	5	626	5	411	1	1,001	15	292
	378		137		62		84		17		5	
Iowa												
Cornell Coll	1	13	1	13								

GRANTEE OR CONTRACTOR		PROGRAM GRANTS AND CONTRACTS																	
		TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Agriculture, Earth, and Ocean Sciences		Scientific, Technological, and Interdisciplinary Affairs		Advanced Scientific Computing					
		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Kentucky																			
Rurray State Univ		1	61					1	61										
Northern Kentucky Univ		1	22					1	22										
U of Louisville Res Fdn		1	93					1	93										
Univ of Kentucky		45	2,259	18	844	8	506	11	645	3	121	5	130						2
Univ of Louisville		5	349	2	69			2	228			1	59						
Western Kentucky Univ		1	51	1	43		8												
TRAVEL & INDIVIDUAL AWARDS		1	43	1	43														
STATE TOTAL:		55	2,981	22	1,020	8	514	16	1,843	3	121	6	190						2
Louisiana																			
La St Univ Baton Rouge		40	2,618	14	839	3	177	13	992	8	572	2	30						6
La St Univ Medical Center		2	101					2	101										
La Union Marine Center		2	85					1	2	1	82								
Louisiana Bd of Regents		1	75																
Louisiana State U Sys Off		1	37					1	37			1	75						
Nicholls State University		1	44																
Tulane Univ-Delta Reg Pct		1	35							1	44								
Tulane University		17	627	10	296	1	45	1	35										
Univ of New Orleans		2	80	2	80			6	332										
Univ of Shreveport Louisiana		5	241	2	155			3	86										
TRAVEL & INDIVIDUAL AWARDS		1	2			1	2												
STATE TOTAL:		73	3,959	28	1,374	5	225	27	1,548	10	698	3	185						6

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Social Sciences		Atmospheric, Earth, and Ocean Sciences		Social, Technological, and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
MAINE														
Bates College	2	92	1	13			1	79						
Bigelow Lab For Ocean Res	17	1,090							16	1,093	1	4		
Boudoin College	0	10	0	10										
Calby College	1	119	0	11			1	107						
Jackson Lab	3	202					3	202						
Mt Desert Island Biol Lab	4	100					4	100						
Pembroke Indian Nation	1	63					1	63						
Sea Run Inc	0	105									0	105		
St Joseph's College	0	3	0	3										
The Acadia Institute	1	60									1	60		
Univ of Maine Orono	19	1,072	4	365	5	381	6	363	3	596	1	22		
Univ of Southern Maine	1	40			1	40								
TRAVEL & INDIVIDUAL AWARDS	1	2			1	2								
STATE TOTAL:	3,003	50	5	484	7	432	16	1,080	19	1,689	3	232		
MARYLAND														
Adv Tech Laboratories	0	30									0	30		
Advanced Tech & Res Inc	0	149									0	149		
Amer Physiologist Soc	1	3					1	3						
Amer Soc For Plant Physiol	1	15					1	15						
Amer Soc of Plant Chem	1	25					1	25						
Amer Type Culture Collect	3	203					3	203						

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Social Sciences		Astronomical, Earth and Ocean Sciences		Scientific Technological and International Affairs		Ancient Scientific and Cultural	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Maryland														
Applied Physics Lab (JNU)	1	116							1	116				
Applied Research Corp	1	11							1	11				
Capital Systems Group Inc	4	511			4	149						4	361	
Consolidated Visual Ctr	1	37	1	37	1	34								
Dynamic In Situ Seatech	1	40												
Energy Concepts Company	1	40												
Fed of Amer Soc Exp Biol	3	8					3	8						
Geonics Labs Inc	1	39												
H M Jackson Fed Mtry Red	3	96					3	96						
IMA Corporation	2	91			1	1						1	39	
John F Kennedy Institute	2	112					2	112						
Johns Hop U-Ches Bay Inst	7	753					1	40	6	713				
Johns Hop U-HygePubl Hlth	2	102					2	102						
Johns Hop U-Sch of Med	9	635	1	87			8	548						
Johns Hopkins University	77	6,752	26	2,523	13	931	19	1,724	18	1,952	1	19		
Lebanese-Seyfo Art & Photo	1	9	1	9										
Loyola College	1	64					1	64						
Martin Marietta Corp	1	185	1	185										
Morgan State University	1	285												
Net Bur of Stand Grad Sch	1	4	1	4										
Natl Ctr for Health Stat	1	135					1	135						
Quantum Research Corp	4	463										4	463	
Savern Graphics Inc	1	9					1	9						
T S Associates Inc	1	40												

PAGE: 22

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GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Behavioral and Social Sciences		Astronomical, Earth, and Ocean Sciences		Sciences, Technology, and Interdisciplinary	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Massachusetts												
Beth Israel Hospital	1	19									1	19
Beth Israel Hospital	1	129					1	129				
Beth Israel Hospital	2	134					2	134				
Boston College	12	638	2	92	2	96	3	292	4	244	1	4
Boston College	10	595					9	573			1	21
Boston College	35	2,482	11	882	1	94	17	1,268	4	293	2	40
Boston University	44	3,285	19	1,333	0	37	21	1,744	1	63	3	105
Boston University	0	188									0	188
Boston University	0	186									0	186
Charles River Assoc Inc	3	86									3	86
Charles River Assoc Inc	3	408			2	881					1	19
Charles River Assoc Inc	2	128					1	78	1	78	0	77
Charles River Assoc Inc	0	77									0	77
Clark University	11	966	5	232	0	43	4	239	1	45	1	6
Clark University	2	169					2	169				
Clark University	1	38			1	19	0	19				
Clark University	0	169									0	169
Clark University	0	188									0	188
Clark University	0	48									0	48
Clark University	1	80	0	22					1	66		
Clark University	1	26			1	26						
Clark University	0	48									0	48
Clark University	0	39									0	39
Clark University	1	85							1	85		

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Astronomical, Atmospheric, Earth and Ocean Sciences		Scientific, Technological and Environmental Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Massachusetts														
Halcy & Aldrich Inc	0	30									0	30		
Hampshire College	2	63					2	63						
Harvard Univ-Med Sch	7	380	1	32			6	347						
Harvard Univ-Observatory	11	442	1	247	1	19			9	646			0	9
Harvard Univ-Sch Pub Hlth	2	112	1	63			1	69						
Harvard University	157	13,726	46	6,542	0	214	82	5,117	21	1,420	0	213	0	14
Isac Corporation	0	160									0	160		
Lincoln Laboratory	1	160			1	160								
Manlabs Inc	1	127	1	127										
Marine Biological Lab	11	1,377					8	679	3	697				
Mass Eye & Ear Infirmary	1	35					1	35						
Mass General Hospital	2	113					2	113						
Mass Inst of Tech	302	30,886	107	19,316	10	9,194	40	2,972	47	6,978	10	379	0	4
McLean Hospital	1	40					1	40						
Mertis Corporation	0	00									0	00		
St Marys Cal	1	25	1	25										
Stambeam Corporation	0	39									0	39		
Sell Bureau of Econ Res	27	1,990					22	1,805			5	592		
Westport Dynastec Inc	0	39									0	39		
Northeast Radio Obs Corp	2	1,526							2	1,526				
Northeastern University	40	2,527	25	1,678	5	331	7	365	1	90	2	29	0	20
OPTRA Inc	0	37											0	37
Optima System Inc	0	40											0	40
Physical Sciences Inc	1	151			1	113							0	39

PAGE: 25

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Behavioral Social Sciences		Astronomical, Atmospheric, Earth, and Ocean Sciences		Space, Technological, and International Affairs	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Massachusetts												
Radiation Run Devices Inc	0	199									0	199
Retina Found	1	72					1	72				
Robert B Brigham Hospital	1	26					1	26				
Scientific Systems Inc	0	97									0	97
Semer Eng Assoc (SEA)	0	39									0	39
Signatron Inc	0	39									0	39
Simons College	0	17	0	17								
Smith College	4	109	3	36					1	72		
Southeastern Mass Univ	3	242	2	172	1	69						
Sports Systems Inc	0	99										
Spire Corporation	0	39									0	99
Technology & Regl Systems	1	5									0	39
Tracer Tech Inst/Ece	0	39									1	5
Tracer Technologies Inc	1	643									0	39
Tufts Univ--Sch of Med	2	174			1	195					0	667
Tufts University	13	711	6	208	2	141	4	211	1	69		
U Mass Med Sch--Worcester	5	380					5	310				
Univ Hospital Inc	1	11									1	11
Univ of Mass Amherst	110	18-814	37	4-687	23	1-774	30	2-110	9	1-426	3	96
Univ of Mass Boston	7	270	2	60			4	200			1	1
University of Lowell	6	294	3	192	1	70			1	20	1	11
Visual Intelligence Corp	0	160									0	160
Wellesley Col	4	302	0	37								
Wheaton College	1	19										

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Social Sciences		Agriculture, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advisory Services, Consulting	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Massachusetts														
Whitehead Inst. Biomed Res	1	100					1	100						
Wellesley College	9	405	4	139	0	35	4	184	1	47				
Woods Hole Ocean Inst	122	20,342	1	10			4	547	116	19,730	1	54		
Worcester Fdn Exp 810	3	177					3	177						
Worcester Polytech Inst	13	423	1	39	10	473	1	61			1	50		
TRAVEL & INDIVIDUAL AWARDS	15	327	4	133			6	166	1	27				
STATE TOTAL:		110,017		36,394		13,934		20,315		34,121		5,205		56
		1,050		280		137		30		253		56		
Michigan														
Andrews Univ	1	45					1	45						
Calvin College	3	81	2	61					1	39				
Central Mich Univ	1	10	1	10										
Combustion & Fuel Res Inc	0	79									0	79		
Eastern Michigan Univ	3	79												
Electrocon Internat'l Inc	0	30					1	20	2	58		0	39	
Grand Valley St College	0	0	0	0										
Hope College	6	270	3	131			2	129	1	8				
Industrial Tech Institute	3	189									3	189		
KMS Fusion Inc	0	133									0	133		
MI State of Commerce Dept	1	63												
Mich St Univ-Agr Exp Sta	1	50												
Mich Technological Univ	15	442	4	248	5	255	2	69	9	224				

PAGE: 27

PAGE: 77

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Agricultural and Social Sciences		Astronomical, Earth and Ocean Sciences		Scientific, Technological and Environmental Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Michigan														
Michigan Cancer Fdn	1	47					1	42						
Michigan Molecular Inst	1	103	1	103										
Michigan State University	94	10,950	38	10,017	13	775	31	2,052	5	100	6	303		
Oakland Univ	2	56	2	56										
Quest Product Develop Ltd		38										38		
U of Mich-Ann Arbor-Med	6	421					6	421						
U of Mich-Ann Arbor	230	19,848	67	6,308	47	3,516	67	5,255	30	2,652	10	262	1	44
U of Michigan-Dearborn	1	30	1	30										
University of Detroit	1	45	1	45										
Wayne St Univ-Sch of Med	3	117					3	117						
Wayne State University	29	2,445	19	1,170	4	220	4	325		13	2	307		
Western Mich Univ	2	137			2	137								
TRAVEL & INDIVIDUAL AWARDS	5	396	2	64			3	132						
STATE TOTAL:	38,433	17,886	192	123	4,526	9,987	3,093	22	1,019	69	22	1	52	
Minnesota														
Beth Celsior-Bethel Col	1	100					1	100						
Bio-Metric Systems Inc		156										156		
Carleton College	4	103	3	70							1	25		
Col of St Catherine	1	52					1	52						
Col of St Thomas	1	21	1	21										
Control Data Corporation	2	153							2	153				

PAGE: 20

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Biomedical Sciences		Atmospheric and Space Sciences		Sciences for Environmental and Societal Affairs		Ancient, Medieval, and Modern History	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Minnesota														
Henrywell Inc./Comp-Select	1	165			1	165								
Minnesota State University	1	23	1	23										
Nayo Foundation	3	194			1	57	2	137						
Robert C Pritch Consulting	"	48												
Rachelle Crystal Corp	"	35												
St John's University	"	4	"	4										
St Olaf College	1	38	"	16					1	22				
U of Gray Prebunator Bto	1	92					1	92						
U of Minnesota Exp Sta	1	61			1	61								
U of Minnesota Inst of Tech	2	30	1	36	1	2								
U of Minnesota Sch	5	442					6	442						
U of Minnesota Duluth	3	185	1	43					2	102				
U of Minnesota at St Paul	24	1,698	4	118	7	499	12	1,053			1	26		
University of Minnesota	109	12,916	63	4,755	30	1,891	35	1,790	15	1,055	6	127	2	3,295
TRAVEL & INDIVIDUAL AWARDS	2	52					2	52						
STATE TOTAL:	16,277		74	5,057	87,679		3,010		38	1,375	8	412	3,295	2
Mississippi														
Jackson State University	1	267									1	267		
Millissippi Col	"	9	"	9										
Mississippi College	1	29					1	29						
Mississippi Sea & Dev Ctr	1	75									1	75		

PAGE: 79

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Atmospheric Earth and Ocean Sciences		Scientific Technological and International Affairs		Advanced Research and Technology Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Mississippi														
Mississippi State Univ	1	3					1	3						
Univ of Miss Medical Ctr	3	191					3	191						
Univ of Southern Miss	2	133	2	133										
University of Mississippi	12	762	3	251	5	171	2	226	1	24	1	16	7	
STATE TOTAL:	21	1,041	5	394	5	171	7	452	1	24	3	361	7	
Missouri														
Brewer Science Inc	1	93												93
Central Inst for the Deaf	2	182			1	69	1	113						
Grady College	1	65	1	65										
Leetronics Research Inc	1	117												117
Mo Botanical Garden	10	575					0	512			2	62		
Northeast Mo State Univ	1	42					1	42						
Southwest Mo State Univ	1	64							1	64				
St Louis Univ-Sch of Med	4	196					3	161						39
St Louis University	5	225	1	17					3	170	1	18		
Univ of Mo-Sch of Med	1	131					1	131						
Univ of Missouri KC	1	29	1	29										
Univ of Missouri Rolle	10	1,137	4	339	10	628			3	169	1	8		
Univ of Missouri St Louis	5	338	2	166			2	166	1	19				
Univ of Missouri-Columbia	37	2,098	5	338	9	967	10	1,100	4	174	1	17		
Wash Univ-Sch of Medicine	7	358					7	358						

Page: 30

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Agriculture, Earth, and Ocean Sciences		Health, Technology, and International Affairs		Advanced Research, Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Missouri														
Washington University	71	3,488.6	25	966	10	893	20	986	10	478	6	92		
William V. Steeger		00										00		
FRANK L. INDIVIDUAL AWARDS	1	63	1	63										
STATE TOTAL:	72	3,551.6	26	1,029	10	893	20	986	10	478	6	92		
Montana														
Montana State University	22	1,615	6	706	5	336	6	976	3	193	2	11		
University of Montana	7	278					6	196	2	73	1	10		
STATE TOTAL:	29	1,893	6	706	5	336	10	1,172	5	266	3	21		
Nebraska														
Father Flanagan Boys Home	1	15					1	13						
Univ. of Nebraska at Omaha	6	125					3	98	1	26				
Univ. of Nebraska-Lincoln	65	3,924	18	1,566	3	134	16	805	3	1,183	5	164		
STATE TOTAL:	72	4,064	24	1,685	3	134	19	916	4	1,215	5	174		
Nevada														
Desert Res. Inst.-U. of Nev.	6	590					1	41	4	545	1	3		

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Behavioral Sciences		Agricultural and Environmental Sciences		Social and Behavioral Sciences		Unallocated	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Nevada														
University of Nevada-Reno	14	1,025	3	192	4	436	3	145	3	174	1	19		
STATE TOTAL:	29	1,016	3	192	4	436	4	107	7	721	2	18		
New Hampshire														
Bramming Engineering Corp	0	0									0	0		
Creore NBB Inc	0	30									0	30		
Dartmouth Col-Med Sch	1	50					1	50						
Dartmouth Col-Thayer Eng	10	620			6	305			3	309	1	6		
Dartmouth College	19	1,131	5	200			10	756	3	107	1	26		
Robert M Krichman Inc	1	314							1	114				
Univ of N H Durban	19	1,006	6	200	1	66	3	170	7	470	2	85		
Veras Corporation	0	94									0	94		
STATE TOTAL:	50	3,101	11	401	7	372	14	980	14	1,050	4	296		
New Jersey														
Audita and Surveys	1	00									1	00		
Bell Laboratories	1	1,000											1	1,000
Bush Campus-Rutgers Univ	29	2,356	22	1,850	6	049	0	26			1	19	0	17
Cambridge Hydraulics Inc	0	39									0	39		
Chenier Corporation	0	159									0	159		

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Astronomical Earth and Ocean Sciences		Scientific Technological and Interdisciplinary Areas		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
New Jersey														
Computer Horizons Inc	2	391									2	191		
Consortium for Sci Comp	2	8,088												2 8,088
Continuum Dynamics Inc	•	39									•	39		
Educational Testing Serv	1	18					1	18						
Patriciah Dickinson Univ	2	45					1	36			1	9		
Patriciah D U-Tenness	1	62					1	62						
Pish Technology Sandy Hk	1	1					1	1						
Inst For Advanced Study	5	1,272	5	1,246					•	26				
Interactive Radiation Inc	•	201									•	201		
M L Energie Inc	•	88									•	88		
Montclair State Col	•	21	•	21										
New Jersey Inst of Tech	2	154			2	154								
New Jersey Medical School	3	208					3	208						
Princeton Univ Press	2	189	•	22			2	167						
Princeton University	101	11,891	49	6,881	33	2,169	27	1,529	26	1,700	6	375		
Ramapo College of N J	•	9	•	9										
Rider College	1	13	1	13										
Rutgers Medical School	3	198					3	198						
Rutgers U-Camden Campus	2	72	1	34			1	35						
Rutgers U-Camden Coll	1	63	1	63										
Rutgers U-Libington Col	2	72					2	72						
Rutgers U-Newark Campus	3	138					2	112			1	26		
Rutgers Univ-Cook College	5	267			1	29	3	218	1	28				
Rutgers University	81	5,498	47	3,365	5	508	23	1,376	3	338	3	189		

PAGE: 33

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Sciences and Social Sciences		Agriculture, Forestry, and Ocean Sciences		Scientific, Technological, and International Affairs	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
New York												
Albany Medical Col	1	36					1	36				
Alfred Univ St Col Corcoran	2	96	2	96								
Alfred Univ	2	61	1	5	1	56						
Amer Inst of Chem Eng	1	36			1	36						
Amer Inst of Physics	1	39					1	33	0	6		
Amer Museum of Nat Hist	5	302					0	392	1	99		
Amer Soc of Civil Eng	1	6			1	6						
Amer Soc of Human Genet	1	12					1	12				
American Assn Emerg Soc	0	180			0	100						
Asian Cultural Cncl Inc	1	12									1	12
Barnard College	0	2	0	2								
Baruch Col	1	22	1	22								
Boyc Thompson Inst	0	466					7	456			1	9
Brunswick National Lab	6	449					0	437			2	12
Brooklyn Col	10	400	6	271	2	56	1	58	1	15		
CUNY Col of Staten Island	1	91	1	91								
CUNY Mt Sinai Sch of Med	0	470					7	666			1	0
Cenotus Col	1	7	1	7								
City Col	23	2,220	11	923	0	812	3	106			1	297
Columbia University	32	1,929	12	467	16	720	5	326			1	7
Climatronics Corporation	0	37									0	37
Col at Cortland	1	76					1	76			1	15
Col at Fredonia	1	15										
Col at Genesee	1	19					1	19				

GRANTEE OR CONTRACTOR		PROGRAM GRANTS AND CONTRACTS											
		TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Atmospheric Earth and Space Sciences		Special Technical and Interdisciplinary Affairs	
		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
New York													
Cell at New Paltz		2	48	2	48								
Cell at Plattsburgh		2	75					2	75				
Cold Spring Harbor Lab		11	314			6	40	10	250			1	12
Colgate University		6	143	2	70			1	37	1	35		
Columbia U Col Phys Sur		7	575					7	575				
Columbia U-Lincolnton Geo Obs		71	9,540					2	114	60	9,409	1	35
Columbia Univ Sys Off		1	62					1	62				
Columbia University		115	10,640	05	7,780	24	4,851	30	2,267	0	477	4	50
Conference Board Inc		2	124									2	124
Cornell U St Agr Exp Sta		6	256					4	256				
Cornell Univ - Endowed		150	39,150	69	29,320	30	3,237	25	1,600	23	4,014	7	170
Cornell Univ - State		60	7,492	1	14	2	101	24	2,156			9	3,213
Cornell Univ Medical Ctr		5	330					5	330				
Cornell University		67	6,013	29	2,322	17	3,100	10	912	2	303	1	13
Ctr for Policy Res Inc		1	195					1	195				
Cuny Central Sys Off		4	100					4	100				
Cuny Grad Sch 6 Univ Ctr		5	215	1	15	1	99	3	100				
Cuny Lebanon College		6	157	5	167			1	9				
DOSECC Inc		1	300							1	300		
Stek Value Productions		1	100			1	100						
Summit Med Ctr at Brailyn		4	240					4	240				
ElectroSynthetic Co		6	136									6	136
Fordham University		2	57	2	57								
Gen Elec R & D Center		6	376	2	31	4	345						

PAGE 36

GRANTEE OR CONTRACTOR		PROGRAM GRANTS AND CONTRACTS											
		TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Astronomical, Atmospheric, Earth, and Ocean Sciences		Scientific, Technological, and Interdisciplinary Affairs	
		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
New York													
Health Research Inc		4	315					4	315				
Hunter Col		7	668	1	70			5	304			1	294
Instit of Elect Engng		3	35	1	10	2	25						
Instit of Int Education Inc		1	118				0					1	48
Interagency Genl Corp		0	39									0	39
Iowa College		2	68					2	68				
Ithaca Col		1	95	1	95								
Long Island U-Southampton		1	10										
Manhattan Col		1	82			1	82					1	10
Montclairville Col		1	95	0		1	98						
Red Fdn of Buffalo Inc		1	117	1	117								
Museum of the Amer Indian		1	22					1	22				
N Y Acad of Sciences		7	44	3	22			4	22				
N Y Botanical Garden		10	624					10	599			0	25
N Y Univ-Medical Center		6	473					6	473				
Newau City Col		1	20	1	20								
National Audubon Society		2	46					2	46				
Natl Bur of Econ Res-MY		0	568					0	568				
New School for Social Res		3	89					3	89				
New York City Tech Col		1	89							1	89		
New York University		77	6,629	49	4,516	0	338	20	1,372	0	239	0	53
Stagora Scientific Inc		0	193									0	193
Stinson Physics Corp		0	39									0	39
Polytechnic Inst of N Y		27	2,063	15	1,316	7	533			1	196	2	19

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavior and Social Sciences		Astronomical, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advances in Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
New York														
Public Health Res Inst	3	187					3	187						
Science Ctr	6	436	0	516			0	124						
RLI Research Corp	0	99											0	99
Researcher Polytech Inst	50	4,107	17	1,688	28	1,959	1	66	5	427	3	60		
Res Found for Mental Hyg	5	268					5	268						
Resources Plan Access Inst	0	74											0	74
Rochester Inst of Tech	0	19	0	19										
Rochester Univ	28	1,995	3	273	0	42	29	1,669			1	9		
SUNY at Albany	47	2,774	14	643	0	52	17	858	16	1,179				
SUNY at Binghamton	22	865	8	375	1	7	8	380	0	170	1	9		
SUNY at Buffalo	77	4,719	25	1,415	24	1,684	22	934	0	461	2	24		
SUNY at Stony Brook	121	12,532	52	2,413	5	472	37	2,465	23	2,885	4	78	0	17
St Vincens Col	1	29					1	29						
Stam Kettering Cane Res	5	376					5	376						
Steele Res Council	2	151					2	151						
St Univ of NY System Off	3	265					3	265						
Suny Col Env Sci/Parasitology	7	330	1	60	1	46	5	243						
Suny-with Sci Ctr Stony Bk	2	120					2	120						
Syracuse Research Corp	2	209											2	209
Syracuse University	43	3,271	12	1,189	18	787	18	1,318	1	34	2	24	0	40
The Electrosynthesis Co	0	48												
The St Lukes-Rosemead Im	1	47					1	47						
U of Rochester-Med	10	628					8	935	1	81	1	16		
Union College	2	74	1	24			1	45						

PAGE: 30

GRANTOR OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Sciences and Social Sciences		Astronomical, Atmospheric, and Ocean Sciences		Scientific, Technological, and Environmental Affairs		Advanced Scientific Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
New York	6	63			5	58	1	5						
United Emp Trustees Inc	77	8,342	36	5,531	13	1,202	22	1,275	4	266	4	66		
Univ of Rochester	4	272			1	134	1	43	2	105				
Univ of the State of N Y	2	199					2	199						
West Med Ctr at Syracuse	2	37					2	37						
Univ of Syracuse U	4	101	1	24			2	36	1	38				
Wesner College	2	66					2	66						
W Alton Jones Cell Sc Ctr	12	867					11	856			1	11		
Yonkers U-Albert Einstein	1	10					1	10						
Yonkers University	17	473	6	255	4	5	4	156			3	55		
TRAVEL & INDIVIDUAL AWARDS		144,064												
STATE TOTAL:	1,362	643,278	26,422	215,878	28,236	2,011	17,879	5,375						
North Carolina	2	74			1	0	1	66						
Appalachian State Univ	0	138									0	138		
Appl Res Assoc Inc-Alb/Re	0	130									0	130		
C Abaci Inc	1	20	1	20										
Durham Univ	74	6,105	17	1,511	7	675	43	3,655	4	438	3	104		
Duke Univ	10	1,706					1	60	9	1,646				
Duke Univ-Marine Lab	0	461					0	461						
Duke Univ-Sch of Medicine	4	110	1	10					3	100	0	30		
East Carolina Univ	0	30												
Enzyme Technology Res Ctr														

PAGE: 39

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GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Astronomical, Atmospheric, Earth and Ocean Sciences		Scientific, Technological, Environmental Affairs	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Battelle Memorial Inst	1	69	1	69								
Battling Green State Univ	8	375	2	85			5	250	1	39		
C Battlering Res Fdn-Lab	2	193					2	193				
Coe W R Univ-Sch of Med	4	253					4	253				
Coe Western Reserve Univ	69	3,862	22	2,672	8	616	11	403	7	369	1	22
Coe Western Res-Coe Inst	8	675	2	147	5	502	0	10			1	16
Col of Wooster	2	70	2	70								
DeSales Univ	1	27					1	27				
Goold Defense Systems Inc	1	26							1	26		
John Carroll Univ	1	42	1	42								
Kent St Univ	9	682	5	476			4	285				
Kent State University Fdn	3	274	3	276								
Kentron Col	2	65	1	35			1	36				
Mad Col of Ohio at Toledo	2	53					2	53				
Miami Univ Central Office	11	599	2	103			6	395	3	100		
Hocking Col	1	77							1	77		
Oberlin Col	3	140	2	112	1	37	0	19				
Ohio St Univ	110	8,036	62	4,759	14	960	22	1,203	10	912	4	63
Ohio Univ	7	602	4	321			3	276	0	5		
Ohio Wesleyan Univ	1	316					1	316				
Piastronic	0	35									0	35
Research Dynamics-Cine	0	37									0	37
Sapper Res Products Inc	0	39									0	39
U of Cincinnati-Col Med	5	237					5	237				

PAGE: 41

PROGRAM GRANTS AND CONTRACTS														
GRANTEE OR CONTRACTOR	TOTAL		Mathematical and Physical Sciences		Engineering		Biological Behavioral and Social Sciences		Atmospheric and Ocean Sciences		Scientific Technological and Environmental Affairs		Advanced Scientific and Technological	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Ohio														
U of Dayton	1	63					1	63						
Univ of Akron Central Off	1	50			*	25	1	25						
Univ of Akron Rehn Cooper	7	362	3	245	3	104					1	13		
Univ of Cincinnati	31	1,650	17	1,054	6	211	6	151	3	229	3	52		
Univ of Toledo	7	313	3	186	1	123			2	73	1	10		
Universal Energy Systems	*	201									*	201		
Wright State Univ.	3	151	1	25			2	126						
Wright State Univ.	4	27	1	1	2	1					1	24		
STATE TOTAL:														
		19,266		18,881		2,580		6,320		2,033		514		55
		293		138		30		75		32		12		2
Michigan														
Michigan State Univ	25	1,362	13	617	6	316	6	225	1	27	3	176		
Reservoir Simulation Res	*	40									*	40		
Univ Ohio with Sci Ctr	2	153					2	153						
Univ of Ohio	50	2,410	12	462	2	83	23	937	11	664	2	268	*	2
Univ of Toledo	4	262			2	126	1	41	1	75				
STATE TOTAL:														
		4,217		1,079		526		1,358		766		484		2
		81		25		8		30		13		5		
Oregon														
Oregon Research Inc	*	166									*	166		

PAGE: 42

GRANTEE OR CONTRACTOR	TOTAL										Engineering						Biological Sciences and Social Sciences		Agricultural, Mechanical, Earth, and Ocean Sciences		Scientific, Technical, and International Affairs		Advanced Scientific Computing	
	No.		Amount		No.		Amount		No.		Amount		No.		Amount		No.		Amount		No.		Amount	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Oregon																								
Eastern Oregon St College	1	10	1	10																				
Eugene Research Institute	1	232																						
Good Samaritan Hospital C	1	8																						
Lewis and Clark Col	1	10	1	10																				
Oreg Hlth Scis Univ	1	64																						
Oregon Graduate Center	13	837	3	171	3	175	3	266	3	266														
Oregon St U-Agr Exp Sta	1	109																						
Oregon St Univ	189	9,994	14	960	7	503	26	1,917	37	6,351	1	10												
Pacific Slopech Res Assoc	1	33																						
Portland State University	8	287	1	30	2	193	2	28	2	223	1	51												
Reed Col	3	91	1	27			2	63																
Slechte Eng Assoc Inc	1	69																						
Univ of Oregon - Eugene	77	4,402	27	1,825	2	118	32	1,664	12	689	6	84												
TRAVEL & INDIVIDUAL AWARDS	3	71																						
STATE TOTAL:	16,481	3,436	46	1,117	10	71	4,361	76	7,717	76	7,717	7	394	1	1									
Pennsylvania																								
Aced of Nat Sci of Phila	6	478																						
Bryn Mawr Col	7	253	1	39	1	34	2	131	2	86	1	31												
Duquesne Univ	2	78	1	38			1	48																
C & Electronics Inc	1	39																						
Cornegie Inst	1	69																						

PAGE: 43

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Agriculture, Earth and Ocean Sciences		Scientific Technology and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Foreign Grants														
Carnegie Mellon Univ	105	7,992	32	3,343	23	2,230	34	2,828	1	55	5	243	0	3
Carnegie Mellon-Joint Tech	2	93			2	93					0	60		
Carnegie Planning Company	0	60									2	82		
Costed Research Corp	2	82												
Glattstein Col	2	72	0	25			2	47						
Gravel Univ.	37	2,280	9	330	22	1,437	1	15	3	553	2	101	0	25
Guarantee Univ	1	43					1	43			0	40		
Extrude Mass Corporation	0	40												
Franklin & Marshall Col	5	100	2	72			1	32	2	40				
Simon University	1	11							1	11				
Gettysburg Col	1	26							1	26				
Mathematics Res Col & Hosp	2	160					2	160						
Harvard Col	6	210	3	110	1	60	2	115						
Inst For Cancer Research	6	482					6	482						
Inst For Scientific Info	1	30									1	30		
Janelia Col	1	76			1	76								
Lehigh Col	2	60	1	20					1	20				
Lehigh Medical Res Cntr	1	80					1	80						
Lehigh Valley Col	1	10					1	10						
Lehigh Univ	37	2,670	12	780	10	1,312	2	130	0	367	0	105	1	2
Materials Res Society	2	9	0	2	1	0								
Medical College of Pa	1	57					1	57						
Mellon-Pitt-Carnegie Corp	1	215											1	215
Mellon Chem Science Center	3	155					3	155						

PAGE: 60

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Atmospheric, Earth, and Ocean Sciences		Specific Training and Instructional Affairs	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Pennsylvania												
Millersville Univ	1	6					1	6				
West Chester University	2	31	1	21			1	30				
Wilkes Col	1	6	1	6								
Witmer Inst	2	90										
TRAVEL & INDIVIDUAL AWARDS	10	89	3	3	5	6	1	85			1	5
STATE TOTAL:	31	990	20	890	10	24	11	100	5	343	1	266
	100		220		151		102		25		2	
Rhode Island												
Amer Mathematical Soc	6	303	5	979				1			1	25
Brown Univ	100	8,596	46	9,791	15	1,073	20	1,094	10	1,515	1	12
Gordon Res Conference	13	166	4	27	3	16	4	100	2	20		69
Rhode Island College												
Univ of Rhode Isl Sch Ocean	47	5,420					1	53	40	5,032	2	30
Univ of Rhode Island	16	877	3	132	8	546	2	116	2	66	1	15
TRAVEL & INDIVIDUAL AWARDS	2	60	1	63	1	1						
STATE TOTAL:	164	14,693	59	5,499	27	1,637	27	1,364	66	7,635	5	87
	100		59		27		27		66		5	87
South Carolina												
Clemson Univ	20	1,101	5	192	9	670	4	107	1	10	1	20
Erskine Col & Seabury												
	2											

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Business and Behavioral and Social Sciences		Agriculture, Forestry, and Ocean Sciences		Social and International Affairs	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Tennessee												
Deberry Medical Co	5	612					4	312			1	299
Humboldt St Univ	2	60	2	60								
Lab Rider Bottoms Lab	3	1,095	1	650			2	895				
Phyton Technologies Inc	"	36										
St Jude Children Res Hosp	2	107					2	127			4	36
U of Tenn Ctr Health Sci	6	217					5	316			1	3
Univ of Tenn Space Inst	1	17	1	17								
Univ of Tenn at Knoxville	35	2,150	15	1,063	3	180	10	751	2	32	1	125
Univ of the South	1	45					1	45				
Vanderbilt U-Sch of Med	3	110					3	110				
Vanderbilt Univ	30	2,350	10	960	3	230	10	927	2	213	1	10
STATE TOTAL:	91	7,049	29	2,072	6	422	30	3,539	5	272	4	403
Texas												
Ariff Intell Res Inst Tx	1	52	1	52								
Baylor Col of Medicine	9	512					7	407			2	25
Cadex Corporation	1	9			1	9						
Hordley-Spence Univ	1	89									1	50
Midwestern State Univ	"	4	"	4								
North Texas St Univ	5	299	2	90	2	169	1	32				
Pan American University	1	273									1	273
RF Healthco Inc	"	40									"	40

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Behavioral Social Sciences		Astronomical and Earth and Ocean Sciences		Scientific and Technological Environmental Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Texas	63	4,762	32	2,734	14	888	5	486	12	792				27
Rice Univ														
San Houston St Col	1	13	1	13										
Scientific Research Sys	1	48									1	48		
Southern Methodist Univ	14	1,685	9	177	6	232	7	499	3	176				
Southwest Research Inst	2	78							2	78				
Southwestern Univ	1	25							1	25				
St Mary's Univ S Antonio	1	297									1	297		
St Rose St Col	1	294									1	294		
Ten Tech H-Health Sci Ctr	1	99			1	99								
Texas A & M Univ Exp Sta	1	99												
Texas A&M Research Ctr	66	4,688	22	1,423	12	761	15	1,092	13	1,269	9	81		
Texas A&M Univ	46	3,536	21	1,220	3	378	9	391	10	1,484	3	62		
Texas Christian Univ	1	181					1	181						
Texas Tech University	19	1,127	5	381	9	587	3	187	2	198	1			
Texas Woman's Univ	1	3					1	3						
Trinity Univ	4	107	2	117			2	78						
U Houston Sysdev Cernoff	1	52					1	52						
U TM Hlth Sc Houston	6	599					6	599						
U Ten Hlth Sc Ctr Dallas	7	377					7	377						
U Ten Hlth Sc Ctr San Ant	6	464			1	50	5	354						
U Ten Hlth Sc Ctr Houston	5	393					5	393						
U Ten San Antonio	2	251			1	191	1	99						
U Ten-Andran Hespeltumor I	2	160					2	160						
U of Houston-Clear LA Cy	1	17									1	17		

PAGE: 49

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Agricultural, Atmospheric, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Research and Computing	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Texas														
UT MSC/UT Stinehn Red Sch	1	150					1	150						
Univ Tex Aus-Mar Sci Inst	2	143					1	62	1	81				
Univ Tex Aus-Redonald Obs	3	191							3	191				
Univ Tex Aus-Redonald Obs	53	2,928	19	1,197	13	834	12	633	4	141	5	101	*	19
Univ of Mount -Univ Ph.	23	1,437	4	149	2	108	3	165	12	936	2	71		
Univ of Texas at Dallas	5	238	1	75	1	33	2	108	1	13	*	9		
Univ of Texas-Arlington	159	11,482	56	4,595	31	2,852	41	2,485	27	2,276	4	52	*	19
Univ of Texas-Austin	4	315	1	18					2	103	1	314		
Univ of Texas-El Paso	1	13					3	189	1	13				
Univ Space Research Assn	3	189												
Ut Mo Ctr/Grad Sch Bio Sc	2	64	2	64										
TRAVEL & INDIVIDUAL AWARDS														
STATE TOTAL:	36,986		182	2,243	9,237		192	6,872	94	7,756	26	1,738		59
	325													
Utah														
Bio-Renewables Inst Inc	*	36									*	36		
Stematerials Internat Inc	*	48									*	48		
Bennettville Scientific	*	113									*	113		
Brigham Young Univ	8	488	3	268	2	112	3	95			*	172		
Native Plants Inc	2	447	*	21	*	137	2	116			*	40		
Technical Res Association	*	48									*	40		
U of Utah	94	7,238	54	4,827	11	836	15	997	13	558	1	10		
U of Utah-Col of Med	5	238			*	37	5	220						

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Astronomical, Atmospheric, Earth and Ocean Sciences		Scientific, Technological and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
UTAH														
Utah Innovation Center	1	25			1	25								
Utah St Univ	24	2,375	7	550	1	111	7	1,104	8	617	1	9		
Weber St Col	2	54							1	35	1	19		
TRAVEL & INDIVIDUAL AWARDS	1	63	1	63										
STATE TOTAL:	137	11,091	5,642	3,261	15	3,261	32	2,535	22	1,211	3	441		
			65											
VERMONT														
Dufresne-Henry Inc	*	40			1	37					*	40		
Environmental Files	1	37												
Middlebury Col	1	32					1	32						
Univ of Vt-Col of Med	3	162					3	162						
University of Vermont	11	645	5	349	1	51	3	151			2	92		
TRAVEL & INDIVIDUAL AWARDS	1	38							1	38				
STATE TOTAL:	17	976	5	369	3	87	7	346	1	38		132		
											2			
VIRGINIA														
Am Fed of Inf Process Soc	2	107	1	40			*	20			1	127		
Amer Geological Inst	1	62							1	62	*			
Biological Monitoring Inc	*	122										122		
Becking Computer Ser Co	3	2,050											3	2,050

PAGE: 51

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological and Environmental Sciences		Astronomical, Earth, and Ocean Sciences		Scientific and Technological and International Affairs	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Virginia												
Carlson & Finch Assoc Inc	0	39									0	39
Chesapeake Res Consortium Inc	1	305					1	305				
Col of William and Mary	12	982	7	781			3	125	1	50	1	20
Computational Physics Inc	0	67							1	67		
Ctr for Appl Linguistics	1	106					1	106				
D H Wagner Assoc-Yerkes	0	39									0	39
Decision Sci Consort Inc	0	100									0	100
Design Design Studios Inc	1	16	1	3	0	13						
Energeticon Anlys Inc	1	5									1	5
Evaluation Techn Inc	1	31									1	31
George Mason University	5	252	1	30	1	69	3	100				
Hamden-Sydney Col	0	20	0	20								
Linguistic Soc of America	1	0					1	0				
Marine Environment Corp	0	91									0	91
National Graphics Center	1	10			1	10						
Old Dominion Univ	0	435	1	03	0	243	2	06	1	60		
Omega World Transl	2	922			0	275			0	60	2	507
Peterson Photonics	0	112									0	112
Rodford University	0	15	0	15								
Randolph-Macon Col	2	73					2	73				
Society For Risk Analysis	1	5									1	5
Sri Int'l Strat Studies Ct	3	217									3	217
U of Richmond	2	72					2	72			1	20
U of Va-Sch of Med	0	452					7	433				

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Atmospheric, Earth, and Ocean Sciences		Scientific, Technological, and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Virginia	76	4,310	29	1,660	12	965	27	1,342	5	380	3	32		9
University of Virginia	1	90												
US Museum Natural History	9	595	2	75		33	7	395						
Va Commonwealth Univ	3	201					3	201						
Va Commonwealth U-Health Sci	1	98					1	98						
Va Inst of Marine Sci	1	92			1	92								
Va Military Inst	1	20												
Va Poly Inst-Agr Exp Sta	1	12												
Va-St. Univ.	60	3,702	19	1,036	21	1,340	17	889	0	261	7	166		
Virginia Polytechnic Inst	1	45					1	45						
Washington and Lee Univ	4	5	2	2	2	3								
TRAVEL & INDIVIDUAL AWARDS	16,076		3,714		62	3,034	79	4,049	13	867	23	1,970	2,068	
STATE TOTAL:	223		63											
Washington	1	62	1	62										
DMJ-Battelle Nthwest Labs	2	155			1	75	1	79						
DMJ/Mattelle Human Ap Res	1	85	1	85										
Boeing Emgr & Constructn	1	53					1	53						
Eastern Washington Univ		199												
Energy International Inc	2	116					2	91				199		
Evergreen State College	3	230					3	230						
F Hutchinson Cam Res Ctr														
Flm Industries Inc														

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral, and Social Sciences		Astronomical, Earth, and Ocean Sciences		Scientific, Technological, and Environmental Affairs		Advanced Scientific and Technological Combining	
	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
Washington														
George Univ	2	49					1	39			1	10		
Innovative Technology Lab	*	39									*	39		
Issaquah Health Res Inst	1	58					1	58						
Ledex Inc	*	169									*	169		
Phys Dyn Inc-Phys Dyn-See	1	69							1	69				
Sci Appl Intl Corp-West	1	153							1	153				
Sea-Bird Electronics Inc	*	48									*	48		
Signa	*	38									*	38		
U of Wash-Sch of Med	12	758					10	715			2	34		
Univ of Puget Sound	1	86					1	86						
University of Washington	259	23,349	99	5,585	31	1,699	68	4,563	94	11,202	6	129	1	50
Washington State Univ	58	3,617	12	800	11	750	25	1,989	1	17	1	11	*	3
Western Washington Univ	4	288	1	27					3	172				
Willkies Co	*	25	*	25										
TRAVEL & INDIVIDUAL AWARDS	4	37			2	2	1	5			1	28		
STATE TOTAL:	29,683		6,575		2,728		7,908		11,616		11	721	1	53
	345		74		65		114		189					
West Virginia														
Marshall Univ	*	19	*	19										
Nat Radio Astron Observ	2	26,658							2	26,658			*	4
West Virginia University	6	423	2	118	2	167	2	148						
TRAVEL & INDIVIDUAL AWARDS	1				1									
STATE TOTAL:	27,092		2	129	3	168	2	148		26,658			*	4
	4								2					

PA 54

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS											
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Agricultural, Earth and Ocean Sciences		Social, Technological, and Interdisciplinary Areas		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
U.S. GOVERNMENT												
Agr Research Service	1	14							1	14		
Arctic Res Commission	2	266					2	266				
Army-Cent Eng Res Lab	1	15			1	15						
Bureau of Labor Stat	1	225							1	225		
Bureau of the Census	4	422							4	422		
Defense Adv Res Proj Agcy	2	768	1	100	1	100					1	388
Department of Air Force	1	50						1	50			
Department of Energy	1	150							1	150		
Department of State	1	171							1	171		
Department of Treasury	1	38										
Dept of Army-U S Army Mach	1	38	1	38								
Naval Weapons Operates	1	47	1	47								
Dept of Trans-Maritime Adv	1	65						1	65			
Federal Trade Commission	2	25							2	25		
NSA	2	112			1	5		1	107			
NSA-Johnson Space Center	1	3							1	3		
NSA-Lewis Research Ctr	1	1,580									1	1,580
Nat Bur of Standards-Biol	1	3			1	3						
Nat Bureau of Standards	5	596	2	255	3	335						
Nat Endow For Humanities	1	35										
Natl Institute of Health	3	172										
Natl Oceanic Atmos Admin	3	309						3	209			
Office of Naval Res	3	264						2	116			
Office of Personnel Mgmt	1	1							1	1		

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS													
	TOTAL		Mathematical and Physical Sciences		Engineering		Biological, Behavioral and Social Sciences		Agricultural, Environmental, Earth and Ocean Sciences		Specific, Interdisciplinary and International Affairs		Advanced Scientific Computing	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
U.S. GOVERNMENT														
Sellheimian Institution	0	40							0	40				
Sellheimian-Institution	1	80	1	30										
FEDERAL GOVERNMENT TOTAL:		120	1	30										
OTHER GOVERNMENT TOTAL:														
TOTAL:	1	120	1	30										

FISCAL YEAR 1985

PROGRAM GRANTS AND CONTRACTS AWARDED

FROM

U.S. ANTARCTIC PROGRAM ACTIVITIES APPROPRIATION

U.S. ANTARCTIC PROGRAM ACTIVITIES

SUMMARY (Amount in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Alaska	2	135
Arizona	2	56
California	26	2,610
Colorado	3	201
Delaware	4	317
District of Columbia	4	139
Florida	7	553
Illinois	4	203
Indiana	2	213
Kansas	3	257
Maine	4	318
Maryland	2	121
Massachusetts	4	397
Michigan	1	45
Minnesota	2	150
Mississippi	1	10
Nebraska	•	372
New Hampshire	1	120
New Jersey	4	22,590
New Mexico	2	99
New York	10	957
Ohio	13	786
Oregon	2	155
PAGE: 1		

U.S. ANTARCTIC PROGRAM ACTIVITIES

SUMMARY (Amount in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Pennsylvania	2	178
Rhode Island	2	151
South Carolina	1	51
Tennessee	2	126
Texas	4	346
Utah	2	70
Virginia	3	112
Washington	5	359
Wisconsin	3	752
Wyoming	2	151
UNITED STATES TOTAL:	131	33,115
FEDERAL GOVERNMENT TOTAL:	15	77,625
GRAND TOTAL:	146	110,740
PAGE: 2		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Alaska		
U of Alas-Geophys Inst	1	99
Univ Alaska Fairbanks Cam	1	36
STATE TOTAL:	2	135
Arizona		
Arizona State University	2	56
STATE TOTAL:	2	56
California		
California Inst of Tech	1	95
Hubbs-Sea World Res Inst	1	22
Lockheed HRS-Palo Alto	1	96
Point Reyes Bird Observ	2	211
SRI International	1	85
San Jose State University	1	41
Science Appl Intl Corp	1	25
Stanford Univ	1	330
U of Cal SD-Scripps Inst	5	497
U of Cal San Diego	1	31
U of Cal Santa Barbara	2	166
PAGE: 1		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
California		
U of Cal Santa Cruz	3	396
U of Cal-Irvine	1	76
Univ of Cal Los Angeles	4	342
Univ of Southern Cal	3	190
STATE TOTAL:	2P	2,610
Colorado		
Colorado School of Mines	1	49
Univ of Colo at Denver	1	55
University of Denver	1	96
STATE TOTAL:	3	201
Delaware		
Franklin Inst-Bartol Fdn	1	266
Univ Del-Col Marine Stds	3	51
STATE TOTAL:	4	317
PAGE: 2		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
District of Columbia		
Amer Geophysical Union	1	2
Nat Acad Sci-Nat Res Cnl	2	65
Nat Acad of Sciences	1	72
STATE TOTAL:	4	139
Florida		
Florida State University	3	351
Univ of South Florida	2	140
University of Florida	2	61
STATE TOTAL:	7	552
Illinois		
Augustana Col	1	36
Univ of Illinois-Urbana	2	108
University of Chicago	1	58
STATE TOTAL:	4	202
PAGE: 3		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Indiana		
Purdue University	2	213
STATE TOTAL:	2	213
Kansas		
U Kansas Ctr Research Inc	2	247
Nichols State University	1	18
STATE TOTAL:	3	257
Maine		
Univ of Maine Orono	4	318
STATE TOTAL:	4	318
Maryland		
Univ of Md College Park	2	121
STATE TOTAL:	2	121
PAGE: 4		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No	Amount
Massachusetts		
Mass General Hospital	1	148
Woods Hole Ocean Inst	3	249
STATE TOTAL:	4	397
Michigan		
Wayne State University	1	45
STATE TOTAL:	1	45
Minnesota		
Univ of Minn at St Paul	1	13
University of Minnesota	1	136
STATE TOTAL:	2	150
Mississippi		
Univ of Miss Medical Ctr	1	10
STATE TOTAL:	1	10
	PAGE: 5	

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No	Amount
Nebraska		
Univ of Nebraska-Lincoln	*	372
STATE TOTAL:	*	372
New Hampshire		
Univ of N H Durham	1	120
STATE TOTAL:	1	120
New Jersey		
ITT Antarctic Servs Inc	4	22,598
STATE TOTAL:	4	22,598
New Mexico		
N M Inst of Mining & Tech	2	99
STATE TOTAL:	2	99
PAGE: 6		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
New York		
Columbia U-Lamont Geo Obs	7	805
Cornell Univ - Endowed	1	39
SUNY at Albany	1	80
Univ of Rochester	1	27
STATE TOTAL:	10	957
Ohio		
Kent St Univ	1	19
Ohio St Univ	12	766
STATE TOTAL:	13	786
Oregon		
Oregon St Univ	2	155
STATE TOTAL:	2	155
Pennsylvania		
Franklin Inst	1	101
Univ of Pittsburgh	1	76
STATE TOTAL:	2	177

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR 	PROGRAM GRANTS AND CONTRACTS	
	No	Amount
Rhode Island		
Univ of RI/Grad Sch Ocean	2	151
STATE TCTAL:	2	151
South Carolina		
Univ of S C at Columbia	1	51
STATE TCTAL:	1	51
Tennessee		
Univ of Tenn at Knoxville	1	53
Vanderbilt Univ	1	72
STATE TCTAL:	2	125
Texas		
Rice Univ	1	62
Texas A&M Research Fdn	2	91
Univ of Houst -Univ Pk.	1	186
STATE TOTAL:	4	340
		PAGE: 8

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Utah		
Utah St Univ	2	70
STATE TOTAL:	2	70
Virginia		
Blue Pencil Group Inc	1	15
University of Virginia	1	47
Virginia Polytechnic Inst	1	49
STATE TOTAL:	3	112
Washington		
University of Washington	5	359
STATE TOTAL:	5	359
Wisconsin		
Univ of Wis-Madison	3	752
STATE TOTAL:	3	752
PAGE: 9		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Wyoming		
University of Wyoming	2	151
STATE TOTAL:	2	151
UNITED STATES TOTAL:	131	33,115
PAGE: 10		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No	Amount
DEPARTMENT OF COMMERCE		
Library of Congress	1	152
Smithsonian Institution	1	136
AGENCY TOTAL:	2	289
DEPARTMENT OF DEFENSE		
C Navy-Av Fac & Eng Comm	3	840
Natl Oceanic Atmos Admin	*	4
AGENCY TOTAL:	3	845
DEPARTMENT OF INTERIOR		
Department of Interior	1	6
AGENCY TOTAL:	1	6
DEPARTMENT OF JUSTICE		
Geological Survey	1	300
AGENCY TOTAL:	1	300
* PAGE: 11		

U.S. ANTARCTIC PROGRAM ACTIVITIES

GRANTEE OR CONTRACTOR DEPT OF TRANSPORTATION	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
U S Coast Guard	1	15,000
AGENCY TOTAL:	1	15,000

NATL AERO & SPACE ADMIN		
NASA	1	39
NASA-Goddard Space Flight	1	96
AGENCY TOTAL:	2	135

NATL OCEAN ATMOSP. ADMIN		
Pacific Environmental Grp	1	12
AGENCY TOTAL:	1	12

OFFICE OF SCIENCE & TECH.		
Department of Defense	4	61,036
AGENCY TOTAL:	4	61,036

FEDERAL GOVERNMENT TOTAL:	15	77,625

GRAND TOTAL:	146	110,740

600

FISCAL YEAR 1985

PROGRAM GRANTS AND CONTRACTS AWARDED

AND

FELLOWSHIP AWARDS

FROM

SCIENCE AND ENGINEERING EDUCATION

ACTIVITIES APPROPRIATION

SUMMARY (Amounts in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Alabama	7	230	3
Alaska	4	76	1
Arizona	6	507	11
Arkansas	6	90	
California	64	15,582	435
Colorado	15	1,096	14
Connecticut	9	1,138	45
Delaware	3	118	
District of Columbia	24	5,275	3
Florida	14	532	14
Georgia	17	1,251	12
Hawaii	6	276	1
Idaho	3	57	
Illinois	24	3,093	81
Indiana	14	1,136	20
Iowa	12	513	3
Kansas	11	961	4
Kentucky	13	471	1
Louisiana	9	346	2
Maine	6	41	
Maryland	18	1,894	25
Massachusetts	36	8,234	305
Michigan	23	2,214	45
PAGE: 1			

SUMMARY (Amounts in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Minnesota	23	1,553	19
Mississippi	7	285	1
Missouri	13	1,096	11
Montana	4	194	
Nebraska	8	299	
Nevada	3	35	
New Hampshire	6	308	1
New Jersey	15	2,295	78
New Mexico	5	253	5
New York	61	9,495	113
North Carolina	21	1,682	37
North Dakota	3	212	
Ohio	25	1,256	17
Oklahoma	9	538	4
Oregon	15	1,295	8
Pennsylvania	37	4,876	67
Rhode Island	5	114	5
South Carolina	11	795	1
South Dakota	5	96	1
Tennessee	6	72	1
Texas	23	2,512	40
Utah	8	460	8
Vermont	7	109	1
PAGE: 2 .			

SUMMARY (Amounts in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Virginia	13	1,151	11
Washington	16	1,466	30
West Virginia	7	242	
Wisconsin	27	2,858	36
Wyoming	4	800	1
UNITED STATES TOTAL:	731	80,699	1,521
FEDERAL GOVERNMENT TOTAL:	1	469	
U.S. POSSESSION TOTAL:	5	113	2
FOREIGN COUNTRIES TOTAL:	12	285	
GRAND TOTAL:	749	81,487	1,523
	PAGE: 3		

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Alabama			
Auburn High School	1	5	3
Auburn Univ	2	188	
Birmingham Southern Col	1	7	
Kinston High School	1	5	
Univ of South Alabama	1	16	
University of Alabama	1	7	
STATE TOTAL:	7	230	3
Alaska			
Barrow High School	1	5	1
Lathrop High School	1	5	
Sheldon Jackson College	1	49	
Univ of Alaska Anchorage	1	17	
STATE TOTAL:	4	76	1
Arizona			
Arizona State University	3	326	2
Kofa High School	1	5	9
University of Arizona	1	171	
Westwood High School	1	5	
STATE TOTAL:	6	507	11
PAGE - 1			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Arkansas			
Arkansas Senior H S	1	5	
Bryant High School	1	5	
Hendrix College	1	14	
Ouachita Baptist Univ	1	18	
So Ark Univ Main Campus	1	8	
Univ of Central Arkansas	1	39	
STATE TOTAL:	6	90	
California			
Cal St Col San Bernardino	2	23	
Cal St Col at Bakersfield	1	7	
Cal St Poly Univ Pomona	2	240	
Cal St Univ Fullerton	2	57	
Cal St Univ Long Beach	1	17	1
Cal St Univ Northridge	2	117	
Cal State Univ Fresno	1	50	
Cal State Univ Sacramento	1	9	
Calif St U San Lu Obispo	3	98	
California Inst of Tech	2	949	45
California Lutheran Col	1	14	
Claremont Graduate School	1	17	1
Claremont " Ctr Syst Off	1	27	
PAGE: 2			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
California			
Harvey Mudd Col	3	144	
Humboldt State University	1	50	
Loyola Marymount U	1	23	
Patrick Henry Junior H S	1	5	
Point Loma College	1	7	
Pomona Col	1	8	
Prism Productions Inc	1	1,896	
Rand Corporation	2	773	
Rolling Hills High School	1	5	
SRI International	1	168	
San Diego State Univ	1	83	
San Jose State University	2	157	
Sonoma State University	3	127	
Stanford Univ	3	3,197	170
The Exploratorium	1	50	
U of Cal San Diego	1	461	29
U of Cal San Francisco	1	205	12
U of Cal Santa Barbara	2	225	9
U of Cal Santa Cruz	1	85	5
U of Cal-Irvine	1	51	3
Univ of Cal Los Angeles	2	1,306	17
Univ of Cal Riverside	2	118	4
Univ of Cal-Berkeley	8	4,441	124
Univ of California-Davis	1	273	13
	PAGE: 3		

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
California			
Univ of San Francisco	1	50	
Univ of Southern Cal	1	34	2
STATE TOTAL:	64	15,582	435
Colorado			
Amer Indian Sci&Eng Soc	1	190	
Biol Scs Curriculum Study	2	230	
Carnedy Junior H S	1	5	
Colorado State University	2	34	2
Denver Audubon Society	1	57	
Fort Lewis College	1	11	
Pomona High School	1	5	
Soc Sci Educ Consortium	1	92	
Univ Colorado at Boulder	4	445	12
Univ of Colo at Denver	1	23	
STATE TOTAL:	15	1,096	14
Connecticut			
Darien High School	1	5	
Eastern Conn St Col	1	33	
PAGE: 4			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Connecticut			
Farmington High School	1	5	
St Joseph College	1	19	
University of Bridgeport	1	47	
University of Connecticut	1	17	1
University of Hartford	1	49	
Yale University	2	961	44
STATE TOTAL:	9	1,138	45
Delaware			
Manby Junior High School	1	5	
Milton Junior High School	1	5	
University of Delaware	1	108	
STATE TOTAL:	3	118	
District of Columbia			
Alice Deal Junior H S	1	5	
Amer Assoc For Advt Sci	2	49	
Amer Chemical Soc	3	770	
Assn of Science-Tech Ctrs	1	357	
Ballou Senior High School	1	5	
PAGE: 5			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
District of Columbia			
Cosmo's Corporation	1	299	
Council Chief St Sch Off	1	98	
DC Public Schools	1	243	
George Washington Univ	1	17	1
Georgetown University	1	17	1
Howard University	1	17	1
Nath Assn of America	1	259	
Modern Talking Pictures	•	10	
Nat Acad Sci-Nat Res Cnl	2	1,127	
Nat Acad of Sciences	1	181	
Nat Science Tchrs Assoc	3	774	
National Public Radio	1	815	
Native Amer Sci Educ Assn	1	172	
U of DC 6a Ave Harvard St	1	46	
STATE TOTAL:	24	5,275	3
 Florida			
Eckerd College	1	10	
Embry-Riddle Aero Univ	1	20	
Florida State Museum	1	49	
Florida State University	1	29	3
Jacksonville Epsepl H S	1	5	
PAGE: 6			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Florida			
The Sch Bd Broward Cty FL	1	76	
Thomas Jefferson Jr H S	1	5	
Univ of Central Florida	1	17	1
Univ of South Florida	1	17	1
University of Florida	4	293	9
University of Tampa	1	7	
STATE TOTAL:	14	532	14
Georgia			
Atlanta University	1	17	1
Central Ginnett H S	1	5	
Clark College	1	19	
Emory University	3	369	2
Ga Inst Tech Main Campus	2	373	8
Glenn Hills High School	1	5	
Kennesaw College	1	12	
Mercer University	1	38	
North Georgia College	1	12	
SE Consortium Minorit Eng	1	138	
University of Georgia	3	264	1
West Georgia College	1	11	
STATE TOTAL:	17	1,251	12

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Hawaii			
Chaminade U of Honolulu	1	16	
Lolani School	1	5	
McKinley High School	1	5	
Univ of Hawaii-Manoa	3	249	1
STATE TOTAL:	6	276	1
Idaho			
Boise State University	1	47	
Hillside Junior H S	1	5	
Pocatello High School	1	5	
STATE TOTAL:	3	57	
Illinois			
Bradley University	1	40	
Carbondale Community H S	1	5	
Chicago State University	1	4	
Friends of Fermilab Assn	1	255	
Greenville Col	1	8	
Illinois State Univ	2	147	1
Lake Forest College	2	296	
PAGE: 6			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Illinois			
New Trier High School	1	5	
Northern Illinois Univ	1	60	
Northwestern University	2	468	15
Sangamon State University	1	3	
Southern Ill U-Carbondale	1	17	1
St Xavier College	1	15	
Univ of Ill at Chicago	1	220	
Univ of Illinois-Urbana	5	882	31
University of Chicago	2	741	33
STATE TOTAL:	24	3,093	81
Indiana			
Ball St Univ	1	123	
Columbus East High School	1	5	
Concordia Lutheran H S	1	5	
Earlham College	1	9	
Ind U-Purdue U Indpls	1	34	2
Indiana State University	1	17	1
Indiana Univ-Bloomington	3	234	5
Purdue University	2	621	12
Rose-Hulman Inst of Tech	2	77	
Tri-State University	1	9	
STATE TOTAL:	14	1,136	20
PAGE: 9			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Iowa			
Bettendorf High School	1	5	
Central Univ of Iowa	1	13	
Cornell Col	1	13	
Drake Univ	2	58	
Grinnell Col	1	11	
Iowa St U of Science&Tech	1	13	1
Luther College	1	12	
Mason City High School	1	5	
Univ of Iowa	3	380	2
STATE TOTAL:	12	513	3
Kansas			
Benedictine College	1	285	
Bethany College	1	15	
Indian Trail Jr H S	1	5	
Kansas State University	3	306	1
Shawnee Mission H S	1	5	
St Mary College	1	39	
U of Kansas Main Campus	2	116	3
Wichita State University	1	186	
STATE TOTAL:	11	961	4
PAGE: 10			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Kentucky			
Centre Col of Kentucky	2	19	
Eastern Kentucky Univ	1	52	
J M Atherton High School	1	5	
Murray State Univ	3	251	
Notre Dame Academy	1	5	
Thomas More Col	1	11	
Univ of Kentucky	2	92	1
Western Kentucky Univ	2	34	
STATE TOTAL:	13	471	1
Louisiana			
Catholic High School	1	5	
Centenary College of La	1	7	
La St Univ Baton Rouge	1	175	
Leesville High School	1	5	
Louisiana State U Sys Off	2	114	1
Univ of New Orleans	1	17	1
Univ of Sthstn Louisiana	1	10	
Xavier Univ of Louisiana	1	10	
STATE TOTAL:	9	346	2
PAGE: 11			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Maine			
Bates College	1	6	
Bowdoin College	1	10	
Colby College	1	11	
Falmouth High School	1	5	
St Joseph's College	1	3	
Telstar Regional H S	1	5	
STATE TOTAL:	6	41	
Maryland			
Amer Assoc of Phys Tchrs	2	559	
Carroll Cty Pub Schools	1	122	
Hands-on-Sci Outreach Inc	1	82	
Hereford Middle School	1	5	
Johns Hopkins University	2	553	22
MD Acad of Sciences	1	136	
Montgomery Co Public Schs	1	125	
Natl Aquarium in Baltim.	1	88	
Severn Graphics Inc	1	8	
Towson State Univ	2	48	
Univ of Md College Park	3	133	3
Univ of Md Eastern Shore	1	26	
Western High School	1	5	
STATE TOTAL:	18	1,894	25

GRANTEE OR CONTRACTOR Massachusetts	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Assumption College	1	8	
Bolt Beranek & Newman Inc	1	419	
Boston University	1	18	2
Buckingham Br/Nicholas HS	1	5	
Childrens Museum-Boston	1	50	
Col of the Holy Cross	1	16	
Emmanuel College	1	22	
Harvard Univ-Med Sch	1	51	3
Harvard Univ-Observatory	1	446	
Harvard University	2	2,074	104
Lesley College	1	317	
Lexington High School	1	5	
Mass Inst of Tech	2	3,263	191
Merrimack College	1	17	
Mt Holyoke Col	2	76	
Museum of Science	1	103	
Public Broadcasting Assoc	1	125	
Simsens College	2	37	
Smith College	2	53	
Southeastern Mass Univ	2	125	
Technical Ed Res Ctr Inc	1	17	
Univ of Mass Amherst	3	868	5
Univ of Mass Boston	1	31	
Wellesley Col	1	14	
PAGE: 13			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Minnesota			
Assoc Col of Twin Cities	1	50	
Bemidji State University	1	357	
Benilde-St Margaret's H S	1	5	
Carleton College	3	114	
Col of St Thomas	1	106	
Concordia Col Moorhead	2	35	
Gustavus Adolphus Col	1	32	
Macalester Col	5	157	
St John's University	1	4	
St Louis Park Sr H S	1	5	
St Mary's College	1	26	
St Claf College	1	16	
Univ of Minn at Morris	1	23	
University of Minnesota	3	617	19
STATE TOTAL:	23	1,553	19
Mississippi			
Hillsaps Col	1	9	
Oak Grove High School	1	5	
Rust College	1	35	
Starkville High School	1	5	
Univ of Southern Miss	2	213	
PAGE: 15			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Mississippi			
University of Mississippi	1	17	1
STATE TOTAL:	7	285	1
Missouri			
Central High School	1	5	
Central Missouri St Univ	1	15	
Northeast Mo State Univ	2	95	
Parbway Central H S	1	5	
Southeast Mo State Univ	1	475	
Southwest Mo State Univ	1	37	
St Louis University	1	82	
Univ of Missouri-Columbia	3	220	2
Washington University	1	153	9
William Jewell Col	1	5	
STATE TOTAL:	13	1,096	11
Montana			
Helena High School	1	5	
Libby High School	1	5	
Mont Col of Mineral Sci	1	9	
PAGE: 16			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Montana			
Montana Cnc'l Tchrs Math	1	174	
STATE TOTAL:	4	194	
Nebraska			
Chadron St Col	1	25	
Concordia Tchrs Col	1	17	
Creighton University	1	93	
Kearney State Col	1	119	
Lincoln High School	1	5	
Nebraska Wesleyan Univ	2	34	
Northwest High School	1	5	
STATE TOTAL:	8	299	
Nevada			
Bonanza H S	1	5	
Reno High School	1	5	
Univ of Nevada Las Vegas	1	25	
STATE TOTAL:	3	35	
PAGE: 17 .			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
New Hampshire			
Antioch-New Eng Grad Sch	1	75	1
Dartmouth College	1	17	
Hillsboro-Deering H S	1	5	
Kimball Union Academy	1	5	
Univ N H Plymouth St Col	1	189	
Univ of N H Durham	1	16	
STATE TOTAL:	€	308	1
New Jersey			
Council For Adv Sci Writ	1	26	76
Educational Testing Serv	2	232	
Georgian Court Col	1	27	
Inst For Advanced Study	1	46	
Millburn High School	1	5	
Montclair State Col	1	21	
Princeton University	3	1,353	2
Ramapo College of N J	1	9	
Rutgers University	1	34	
Trenton State College	1	44	
W Wilson Natl Fellow Fdn	1	490	
Waldwick High School	1	5	
STATE TOTAL:	15	2,295	76

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
New Mexico			
Los Alamos High School	2	10	
New Mexico St University	1	17	1
University of New Mexico	2	226	4
STATE TOTAL:	5	253	5
New York			
Bank Street Col of Ed	2	762	
Barnard College	1	2	
Children's Telev Workshop	1	2,500	
City Col	1	216	
Clarkson University	1	17	1
Col at Brockport	4	521	
Col at Cortland	1	46	
Col at Oswego	2	471	
Colgate University	2	66	
Columbia University	1	256	14
Cornell University	1	1,333	72
Cuny Central Sys Off	1	1	2
Cuny Lehman College	1	8	
Educ Broadcasting Corp	1	50	
Girls Clubs of America	1	50	
Huntington High School	1	5	
PAGE: 19			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
New York			
Inst for Schs of Future	1	351	
Ithaca Col	•	5	
James Lipscomb Inc	1	36	
Long Island U-Brooklyn Ctr	2	137	
Long Island U-Southampton	1	5	
Manhattan Col	3	86	
Manhattanville Col	1	13	
N Y Inst of Technology	1	305	
Nazareth Col of Rochester	1	8	
New York University	1	127	9
Ntl Actn Cncl Minorit Eng	1	100	
Queens Col	3	201	
Rensselaer Polytech Inst	2	120	3
Rochester Inst of Tech	3	153	
Rockefeller Univ	1	135	7
Roslyn High School	1	5	
SUNY at Buffalo	2	18	1
SUNY at Stony Brook	1	138	
Sci Inst For Public Info	1	43	
Sienna College	1	44	
Skidmore Col	1	9	
Syracuse University	1	93	
Teachers College	2	628	
U of Rochester-Sch Med	1	101	
PAGE: 20			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
New York			
Union College	1	68	
Univ of Rochester	3	178	3
Wassar College	1	49	
Yeshiva University	1	17	1
STATE TOTAL:	61	9,495	113
North Carolina			
Appalachian State Univ	1	24	
Cary Senior High School	1	5	
Catawba Col	1	91	
Davidson Col	2	12	
Duke Univ	1	171	15
Elon Col	1	8	
N C St Univ at Raleigh	2	314	5
Pembroke State University	1	10	
Research Triangle Inst	1	232	
Robeson Cty. Brd. Educ	1	69	
Surry Central High School	1	5	
U of N C at Chapel Hill	1	256	15
U of N C at Charlotte	3	109	
U of N C at Greensboro	3	354	1
Univ of NC at Wilmington	1	17	1
STATE TOTAL:	21	1,682	37

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
North Dakota			
Carrington High School	1	5	
Univ of North Dakota	1	202	
Velva Public School	1	5	
STATE TOTAL:	3	212	
Ohio			
Bowling Green State Univ	1	53	
Case Western Reserve Univ	1	85	5
Case Western Res-Case Inst	1	20	
Col of Wooster	1	29	
Denison Univ	1	39	
John Carroll Univ	1	30	
Kent St Univ	1	17	1
Kentron Col	4	56	
Oberlin Col	1	13	
Ohio St Univ	1	118	7
Ohio Wesleyan Univ	2	25	
Rocky River High School	1	5	
U of Dayton	1	99	
Univ of Cincinnati	3	138	4
Univ of Toledo	2	266	
Walnut Hills High School	1	5	
PAGE: 22			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Ohio			
Wittenberg Univ	1	243	
Xavier Univ	1	8	
STATE TOTAL:	25	1,256	17
Oklahoma			
Duncan High School	1	5	
East Central Okla St Univ	1	152	
MacArthur High School	1	5	
Oklahoma State Univ	2	151	2
Univ of Okla	3	135	2
Univ of Tulsa	1	89	
STATE TOTAL:	9	538	4
Oregon			
Cleveland High School	1	5	
Eastern Oregon St College	1	10	
Lewis and Clark Col	1	10	
Linfield Col	1	30	
Oreg Hlth Scis Univ	1	34	2
Oregon Inst of Technology	1	26	
PAGE: 23			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Oregon			
Oregon St Univ	2	249	1
Portland State University	1	668	
Reed Col	2	58	
Rex Putnam High School	1	5	
Univ of Oregon - Eugene	2	175	5
Univ of Portland	1	22	
STATE TOTAL:	15	1,295	8
Pennsylvania			
Bucknell Univ	2	63	
Carnegie Mellon Univ	3	1,228	23
Clarion St Col	1	39	
David B Oliver H S	1	5	
Dickinson Col	1	25	
Edinboro Univ of Penn	1	187	
Franklin & Marshall Col	2	39	
Harriton High School	1	5	
Haverford Col	2	55	
Indiana Univ of Pa	1	132	
Lafayette Col	1	49	
Lehigh Univ	2	191	2
Lycoming Col	1	7	
PAGE: 24			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Pennsylvania			
Mansfield Univ	2	122	8
Metro Pitts. Pub-Brdcstg	1	250	
Pennsylvania State Univ	3	363	
Seton Hill Col	1	25	
Shippensburg Univ	1	5	
St Vincent Col	1	90	3
Temple Univ	2	101	
Thiel Col	1	3	
Univ of Pennsylvania	1	581	
Univ of Pitt-Johnstown	1	19	
Univ of Pittsburgh	3	447	1
Ursinus Col	1	34	
STATE TOTAL:	37	4,076	67
Rhode Island			
Brown Univ	1	48	3
Cranston High School East	1	5	
John F Deering Jr H S	1	5	
Rhode Island College	1	4	2
Univ of Rhode Island	1	51	
STATE TOTAL:	5	114	5
PAGE: 25			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
South Carolina			
Clemson Univ	2	185	1
Erskine Col & Seminary	2	29	
Furman Univ	3	83	
Johnsonville High School	1	5	
Spring Valley High School	1	5	
Univ of S C at Columbia	1	475	
Wofford Col	1	12	
STATE TOTAL:	11	795	1
South Dakota			
Augustana Col	1	12	
Edison Junior High School	1	5	
Northern St Col	1	56	
S D Sch of Mines and Tech	1	17	1
Stevens High School	1	5	
STATE TOTAL:	5	96	1
Tennessee			
Kingsport City Schools	1	16	
Smyrna High School	1	5	
PAGE: 26			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Tennessee			
The Baylor School	1	5	
Univ of Tenn at Chatnga	1	27	
Univ of Tenn at Martin	1	6	
Vanderbilt Univ	1	12	1
STATE TOTAL:	4	72	1
Texas			
Baylor Col of Medicine	2	805	3
Brazoswood High School	1	5	
Corpus Christi State Univ	1	17	1
Midwestern State Univ	1	4	
North Texas St Univ	1	52	
Our Lady Lake Univ of S A	1	5	
Rice Univ	1	153	7
Sam Houston St Col	1	13	
Southern Methodist Univ	2	215	
St Mark's School of Texas	1	5	
Texas A&M Univ	3	303	3
Texas Christian Univ	1	15	1
Trinity Univ	1	44	
U Tex Hlth Sc Ctr Dallas	1	17	1
Univ of Houst -Univ Pk.	3	381	2
PAGE: 27			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Texas			
Univ of Texas-Austin	2	470	22
STATE TOTAL:	23	2,512	40
Utah			
Brigham Young Univ	1	61	4
Dixie High School	1	5	
Monticello High School	1	5	
U of Utah	2	320	3
Utah St Univ	1	17	1
Weber St Col	2	51	
STATE TOTAL:	8	460	8
Vermont			
Champlain Valley Union HS	1	5	
Middlebury Col	2	63	
Norwich Univ	1	11	
Rutland H S	1	5	
St Michael's College	1	7	
University of Vermont	1	16	1
STATE TOTAL:	7	109	1

PAGE: 28

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Virginia			
Amer Geological Inst	1	34	
Ferrum College	1	20	
Hampden-Sydney Col	1	20	
James Madison Univ	1	6	
John Handley High School	1	5	
Maury High School	1	5	
Nat Council Tchrs of Math	1	332	
Omega World Travel	•	200	
Radford University	1	15	
Sci Mus Assn Roanoke Vly	1	64	
U of Richmond	1	7	
University of Virginia	1	205	11
Va Military Inst	1	192	
Virginia Polytechnic Inst	1	33	
STATE TOTAL:	13	1,151	11
Washington			
Eastern Washington Univ	1	206	
Evergreen State College	1	25	
Gonzaga Univ	1	21	
Mercer Island High School	1	5	
Pacific Lutheran Univ	1	6	
PAGE: 29			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Washington			
Seattle Univ	1	34	
Shoreline High School	1	5	
St Martin's College	1	35	
University of Washington	1	718	27
Washington State Univ	4	340	3
Western Washington Univ	1	14	
Whitman Col	1	25	
Whitworth Col	1	30	
STATE TOTAL:	16	1,466	30
West Virginia			
Keyser Primary/Middle Sch	1	5	
Marshall Univ	1	19	
Mount View High School	1	5	
West Liberty St Col	1	6	
West Va Inst of Tech	1	19	
West Va Wesleyan Col	1	10	
West Virginia University	1	176	
STATE TOTAL:	7	242	
PAGE: 30			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
Wisconsin			
Beloit Col	2	60	1
Edgewood Col	1	8	
Lawrence Univ	1	14	
Marquette Univ	1	17	
Milwaukee Public Museum	1	228	
Milwaukee Sch of Eng	2	29	
Ripon Col	1	26	
Spring Valley High School	1	5	
Univ of Wis-Eau Claire	4	128	
Univ of Wis-Madison	6	2,083	
Univ of Wis-Parkside	1	50	35
Univ of Wis-River Falls	1	18	
Univ of Wis-Stout	1	17	
Univ of Wis-Whitewater	1	11	
Viterbo Col	1	5	
Whitnall High School	1	5	
Wis Edu Communicat Board	1	150	
STATE TOTAL:	27	2,858	36
Wyoming			
McCormick Junior H S	1	5	
Twin Spruce Junior H S	2	778	

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Wyoming			
University of Wyoming	1	17	1
STATE TOTAL:	4	800	1
UNITED STATES TOTAL:	731	80,699	1,521
	PAGE: 32		

GRANTEE OR CONTRACTOR DEPARTMENT OF EDUCATION	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Department of Education	1	469	
AGENCY TOTAL:	1	469	
FEDERAL GOVERNMENT TOTAL:	1	469	
PAGE: 33			

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No.	Amount	
Puerto Rico			
Efrain Sanchez Hidakgo	1	5	
Escuela Sup Cecilio L R	1	5	
Int-Amer U Pr San German	1	49	
Inter Amer U Pr-San Juan	1	19	
Univ of P R Rio Piedras	1	34	2
POSSESSION TOTAL:	5	113	2
U.S. POSSESSION TOTAL:	5	113	2
PAGE: 34			

GRANTEE OR CONTRACTOR FOREIGN COUNTRY	PROGRAM GRANTS AND CONTRACTS (Including Fellowships)		FELLOWSHIPS (Number of Fellows Supported)
	No	Amount	
TRAVEL & INDIVIDUAL AWARDS	12	205	
COUNTRY TOTAL:	12	205	
FOREIGN COUNTRIES TOTAL:	12	205	
GRAND TOTAL:	749	81,487	1,523
PAGE: 35			

FISCAL YEAR 1985

PROGRAM GRANTS AND CONTRACTS AWARDED

FROM

NSF SPECIAL FOREIGN CURRENCY APPROPRIATION

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

SUMMARY (Amounts in Thousands of Dollars)	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Texas	3	88
Utah	1	17
Virginia	2	9
Washington	•	2
UNITED STATES TOTAL:	70	1,939
FOREIGN COUNTRIES TOTAL:	18	390
GRAND TOTAL:	88	2,329
PAGE: 2		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
District of Columbia		
Amer Astronomical Soc	•	100
Amer Geophysical Union	•	26
George Washington Univ	2	121
Howard Univ-Col of Med	1	2
Nat Acad of Sciences	•	17
TRAVEL & INDIVIDUAL AWARDS	12	31
STATE TOTAL:	15	299
Florida		
University of Miami	1	50
STATE TOTAL:	1	50
Hawaii		
Univ of Hawaii-Manoa	1	67
TRAVEL & INDIVIDUAL AWARDS	1	2
STATE TOTAL:	2	70
PAGE: 2		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Illinois		
Amer Inst Indian Studies	1	100
IIT Research Institute	•	12
Illinois Inst of Tech	•	1
Univ of Illinois-Urbana	1	62
TRAVEL & INDIVIDUAL AWARDS	1	2
STATE TOTAL:	3	178
Indiana		
Indiana Univ-Bloomington	2	67
U of Notre Dame	1	2
TRAVEL & INDIVIDUAL AWARDS	1	2
STATE TOTAL:	4	72
Iowa		
TRAVEL & INDIVIDUAL AWARDS	2	5
STATE TOTAL:	2	5
PAGE: 3		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Kansas		
U of Kansas Main Campus	1	3
STATE TOTAL:	1	3
Kentucky		
Univ of Kentucky	•	14
STATE TOTAL:	•	14
Maryland		
Univ of Md College Park	2	149
STATE TOTAL:	2	149
Massachusetts		
Brandeis University	1	50
Harvard Univ-Med Sch	1	46
Mass Inst of Tech	1	86
TRAVEL & INDIVIDUAL AWARDS	2	4
STATE TOTAL:	5	186
PAGE: 4		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Michigan		
Michigan State University	•	5
STATE TOTAL:	•	5
Missouri		
Mo Botanical Garden	•	25
Univ of Missouri Rolla	1	22
STATE TOTAL:	1	47
New Hampshire		
Dartmouth College	•	28
STATE TOTAL:	•	28
New Jersey		
Rutgers University	1	34
STATE TOTAL:	1	34
PAGE: 5		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEES OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
New Mexico		
Los Alamos National Lab	1	15
STATE TOTAL:	1	15
New York		
American Assn Engrg Soc	1	18
American Health Fdn	1	26
Asian Cultural Cncl Inc	*	213
Gen Elec R & D Center	*	2
New York Medical Col	1	2
Syracuse University	1	25
TRAVEL & INDIVIDUAL AWARDS	3	5
STATE TOTAL:	7	295
North Carolina		
East Carolina Univ	*	6
N C Agric & Tech St Univ	1	43
TRAVEL & INDIVIDUAL AWARDS	1	2
STATE TOTAL:	2	51
PAGE: 6		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
Pennsylvania		
Pennsylvania State Univ	1	36
TRAVEL & INDIVIDUAL AWARDS	2	5
STATE TOTAL:	3	41
Rhode Island		
Univ of Rhode Island	1	10
STATE TOTAL:	1	10
South Carolina		
Univ of S C at Columbia	2	34
STATE TOTAL:	2	34
Texas		
Texas A&M Univ	1	5
Texas Tech University	1	36
Univ of Texas at Dallas	1	38
Univ of Texas-Arlington	•	6
STATE TOTAL:	- 3	89

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR	PROGRAM GRANTS AND CONTRACTS	
	No	Amount
Utah		
U of Utah	1	17
STATE TOTAL:	1	17
Virginia		
Society For Risk Analysis	•	5
TRAVEL & INDIVIDUAL AWARDS	2	4
STATE TOTAL:	2	9
Washington		
Washington State Univ	•	2
STATE TOTAL:	•	2
UNITED STATES TOTAL:	70	1,939
PAGE: 8		

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

GRANTEE OR CONTRACTOR FOREIGN COUNTRY	PROGRAM GRANTS AND CONTRACTS	
	No.	Amount
TRAVEL & INDIVIDUAL AWARDS	12	37
COUNTRY TOTAL:	12	37
India		
Amerind Publishing Co.ltd	1	50
Andhra University	1	63
Indian Inst Tech, Bombay	1	33
University of Delhi	1	75
COUNTRY TOTAL:	4	221
Pakistan		
University of Karachi	2	131
COUNTRY TOTAL:	2	131
FOREIGN COUNTRIES TOTAL:	18	390
GRAND TOTAL:	88	2,329
PAGE: 9		

WITNESSES

	Page
Bloch, Erich.....	75
Bye, R. E., Jr.....	75
Connolly, John.....	75
Fenstermacher, Jeff.....	75
Good, M. L.....	75
Green, Richard	75
Herz, Charles	75
Jennings, J. D.....	1
Kingsbury, David.....	75
McTague, J. P.....	1
Merrell, William.....	75
Moore, J. H.....	75
Nicholson, Richard.....	75
Shakhashiri, B. Z.....	75
Suh, Nam.....	75
Toye, Sandra	75
Wilkniss, Peter	75

INDEX

National Science Foundation

	Page
Advanced Scientific Computing	211
Assignment of NASA Computer to Carnegie-Mellon	212
Funding in Supercomputer R&D	213
Japanese Competition in Computers	212
Supercomputers	134
Allocating Research Dollars Without Peer Review	155
Astronomical, Atmospheric, Earth and Ocean Sciences Directorate:	
Arctic Research Commission	200
Astronomy	192
Atmospheric Sciences	196
Continental Lithosphere Program	197
Impact of Reductions on Efficiency of Facilities	194
Indemnification of ODP	200
NCAR Computer	196
New Telescope Technology	195
Ocean Drilling Program	198
Reduction at Kitt Peak and SAC Peak	193
Very Long Baseline Array	195
Balance Among Competing Agencies	119
Biological, Behavioral and Social Sciences Directorate:	
1985 Automation Initiative	192
Behavioral and Social Sciences	136
Information Science and Technology	190
Robotics and Cooperation with DOD	191
Broadening Participation in Science and Engineering	138
Collecting Outstanding Debts	228
Contracting Out Services	227
Costs of a PBX System	226
1985 Costs for Telephone, Telegraph and Communications	225
Data Processing	228
Developing Science/Engineering Personnel	100
Engineering Directorate:	
Engineering Research Center	133
Impact of Gramm/Rudman on Long Term Commitments	188
Industry/University Cooperative Research	189
Longevity of ERC's	186
NSF Commitment to ERC's	187
1986 Plans for ERC's	185
1987 Plans for ERC's	185
Fairness Within Context of the Budget Environment	233
Fiscal Year 1987 Federal R&D	121

	Page
Fiscal Year 1986 and Fiscal Year 1987 Support for FTE's	168
Foreign Access to Supercomputers.....	130
Foreign Students in Science and Engineering	128
Geographic and Institutional Distribution.....	157
Impact of Budget on Workforce.....	169
Impact of DOD R&D Funding	131
Impact of Gramm/Rudman on 1987 Emphasis.....	121
Impact on Peer Review Quality Control.....	156
Impacting the Industrial Base.....	150
Importance of Research	78
Indirect Costs.....	131
Industrial Sector Research.....	154
Losing the Competitive Edge	120
Lower Priority Adjustments	122
Manufacturing Research	127
Mathematical and Physical Sciences Directorate:	
Aladdin.....	183
Computer Science Research	177
Coordinated Experimental Research.....	177
Cornell Electron Storage Ring.....	178
Facilities.....	180
Impact of Gramm/Rudman on CESR.....	179
Materials Research Groups.....	181
Materials Research Labs.....	182
Phase-out of Lower Priority Activities in MPS.....	176
Proposed Reprogramming.....	176
Upgrades and New Construction	180
Wisconsin Synchrotron Radiation Center	182
Meshing Research and Education.....	231
Need to Sustain Population of Scientists/Engineers	86
NSF Detailers at OSTP.....	230
On Combining Duties of Director NSF and Science Advisory	164
Peer Review	127
Priorities in FY 1986.....	135
Program Development and Management.....	223
Salary Increases.....	228
Science and Engineering Education Directorate:	
Fiscal Year 1985 Deferral in SEE	138
Fiscal Year 1987 SEE Obligations to Date	67
Impact of 1986 Gramm/Rudman on SEE.....	221
Increasing Teacher Preparation and Enhancement.....	230
Letter From Presidential Award Winner	222
On Advocacy of NSF Institutes	223
Precollege Education of Foreign-Born Faculty.....	152
Precollege Education of U.S. Students.....	152
Priority Setting for SEE in OMB.....	166
Science Education at All Levels	153
Undergraduate Institutions.....	137
Scientific Manpower.....	149
Scientific, Technological, and International Affairs Directorate:	
Attracting Minorities and Women Science	135
Data on Involvement of Women and Minorities.....	171
EPSCoR States.....	157
IIASA.....	202

	Page
Scientific, Technological, and International Affairs Directorate—Continued	
Indo-U.S. Science and Technology Program	202
Minority Research Center of Excellence	140, 210
Policy Research Analysis/Science Resource Studies	210
Salary Gaps	140
Small Business Innovation Program	202
U.S. Membership in IIASA	204
The Bricks and Mortar Issue	164
U.S. Antarctic Program:	
Aircraft Service Life Extension Program	214
Deterioration of Ozone Layer Over Antarctica	219
Icebreaker Operating Costs	214
Impact of Gramm/Rudman on 1986 USAP Plan	216
Impact of Private Expeditions on USAP	218
New Zealand Nuclear Policy	216
Response to 1985 Testimony	218
1985 Testimony	217
Transfer of Operations Budget to Coast Guard	215
U.S. Antarctic Program Icebreaker Services	214
USAP Scientific Return	219
Women Investigators and Research	173

Office of Science and Technology Policy

Academic Basic Research	2
Access to the President	18
Acid Rain	22
Aeronautical Vehicles	25
ARIANE	23
Biotechnology	5
Challenger Tragedy	18
Cleaner Technology	22
Detail of Permanent Positions	41
Detail Costs	28
Detailees	26
ELV's	19
Estimates by Object Classification—FY 1987	42
FCCSET Committee	3
Future Shuttle Launches	19
Gramm-Rudman-Hollings	28
Indirect Costs	24
International Science and Technology	4
Justification of Estimates—FY 1987	45
LANDSAT	29
National Space Strategy	4
Object Classification	38
Opening Statement	1
OSTP Budget	3, 17
OSTP Space Reduction	26, 27
Peer Review	20
Personnel Compensation	27
Personnel Summary	39
Program and Financing	36
Program and Performance	35
R&D Budget	3

	Page
Reduction Pursuant to Public Law 99-177	40
Replacement of Launch Capability	24
Role of OSTP	17
Salaries and Expenses	34
Summary and Highlight Memorandum—FY 1987	31
Summary of Accomplishments in FY 1985	50
Summary of Budget Authority and Outlays	37
Summary of Obligations by Object	48
Telecommunication Responsibility	5
U.S. Investment in R&D	22
Use of Consultants	27